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THESIS

A STUDY OF PROMOTION AND ATTRITION OF MID-GRADE OFFICERS IN THE U.S. MARINE CORPS: ARE ASSIGNMENTS A KEY FACTOR?

by

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March 2005

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This study analyzes the relationship between selection to major in the Marine Corps, and the survival of mid-grade officers to the promotion point of major, by investigating the effects of billet assignments. Specifically, this study looks at the influence of the percentage of time spent in the Fleet Marine Forces (FMF), the percentage of time spent in primary military occupation (PMOS) billet assignments, and the effect of having served in combat, recruiting, security forces, joint, and drill field duties. Models were formulated using groundwork established in previous promotion, retention, and attrition studies. Assignment variables were then introduced to the models. To account for officers' choice for continued service vice forced attrition, the sample was restricted to officers who had attained five years of service. Probit regression was used to find the influence of career assignments on the probability of selection; Heckman's correction was used to control for self-selection bias; and, Cox proportional-hazard regression was used, utilizing the same assignment factors, to find the influence of assignments on the likelihood of attrition. The findings indicated that FMF and PMOS ratios above 60 percent had a negative effect on promotion and retention. Also indicated was that time spent outside the PMOS, in "B" billets, had a positive effect on retention. In a time of budgetary constraints, this information may provide assistance to personnel planners as an alternative to pecuniary measures used to maintain and shape the force.

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A STUDY OF PROMOTION AND ATTRITION OF MID-GRADE OFFICERS IN THE U.S. MARINE CORPS: ARE ASSIGNMENTS A KEY FACTOR?

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ABSTRACT

This study analyzes the relationship between selection to major in the Marine Corps, and the survival of mid-grade officers to the promotion point of major, by investigating the effects of billet assignments. Specifically, this study looks at the influence of the percentage of time spent in the Fleet Marine Forces (FMF), the percentage of time spent in primary military occupation (PMOS) billet assignments, and the effect of having served in combat, recruiting, security forces, joint, and drill field duties.

Models were formulated using groundwork established in previous promotion, retention, and attrition studies. Assignment variables were then introduced to the models. To account for officers' choice for continued service vice forced attrition, the sample was restricted to officers who had attained five years of service. Probit regression was used to find the influence of career assignments on the probability of selection; Heckman's correction was used to control for self-selection bias; and, Cox proportional-hazard regression was used, utilizing the same assignment factors, to find the influence of assignments on the likelihood of attrition.

The findings indicated that FMF and PMOS ratios above 60 percent had a negative effect on promotion and retention. Also indicated was that time spent outside the PMOS, in "B" billets, had a positive effect on retention. In a time of budgetary constraints, this information may provide assistance to personnel planners as an alternative to pecuniary measures used to maintain and shape the force.

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ITB

Major Jerry R. Morgan

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I. INTRODUCTION

> *The most beautiful experience we can have is the mysterious. It is the fundamental emotion that stands at the cradle of true art and true science. Whoever does not know it and can no longer wonder, no longer marvel, is as good as dead, and his eyes are dimmed.*
>
> *—Albert Einstein*

A. INFORMATION

Today there are approximately 18,000 officers serving in the United States Marine Corps. Although this has varied somewhat over time, it has remained consistent that the majority of officers at any given time are in the grade of captain. The majority of officers must be accessed from the civilian sector as second lieutenants at a rate of approximately 1,600 per year. These officers are assigned into an array of primary military occupation specialties (PMOS) necessary to meet mission requirements set forth by the Marine Corps and the Department of Defense.

Marine Corps officers are generally accessed on four by four contracts, which consist of an initial period of four years of active service followed by four years in the Individual Ready Reserve (IRR). Service in the IRR equates to being available for re-call into service given a national emergency. Once officers have completed their initial period of obligated service they are required to make a decision to continue to serve or not serve on active duty. For the Marine Corps to staff its ranks of mid-grade and senior officers, enough junior officers must decide to continue service, and the Marine Corps must decide to promote a sufficient number of officers.

The Marine Corps does not currently offer ground officers bonuses to entice them to continue service in the active ranks. Instead decisions to stay are based on the regular military compensation and other benefits.[1] The assumption is that mid-grade officers, presented with the decision to stay or go, weigh the same differences between military

[1] Congressional Budget Office, "What Does the Military 'Pay Gap' Mean?," (1999). Regular military compensation is defined as a combination of basic pay, housing allowance, food allowance, and the federal tax advantage. Additional benefits include retirement at 20 years of active service, medical, subsidized shopping, and post service education. In addition, there are non-pecuniary aspects that may be equated to taste at the individual level.

and civilian life.[2] Furthermore, the Marine Corps has little control over the military compensation package of its officers. Possible advantages the Marine Corps does have, is selecting who is recruited into the service and also controlling the career progression of officers.

In the past the Marine Corps, especially during the Department of Defense manpower drawdown from 1992 to 1999, had a mechanism beyond officers' desires to stay on active duty – the requirement for augmentation. Except for service academy graduates and Reserve Officer Training Corps students on scholarship, the remainder of new officer accessions came into service on reserve contracts. To continue beyond approximately the five-year mark, an officer had to be augmented into the regular service through a Headquarters Marine Corps (HQMC) board process. Today the augmentation process is offered in conjunction with selection to captain at approximately the five-year mark.

Once officers have been augmented into the regular Marine Corps they are allowed to serve until they have been twice passed for promotion to the next grade. According to statistics provided by the Promotion Branch, Manpower and Reserve Affairs (M&RA), at HQMC, selection for promotion to the grade of major was around 65 to 70 percent during the drawdown, and approximately 85 and 90 percent over the last four years. The first look for promotion to major comes between 10 and 11 years of commissioned service. As authorized by Title 10 United States Code, it is currently, and has been for some time, a Marine Corps policy to continue service for majors who have attained 14 years of service.

The preceding information is important as it explains processes the Marine Corps has control over to shape its forces through forced attrition. However, in between augmentation (today's selection to captain) and selection or non-selection to major, it is the officers who have the choice to continue service or to resign their commissions to re-enter the civilian sector. Hosek and Asch (2002) further support this window by showing

2 Warner and Asch (1995) described the utility of joining the military as $U^M = W^M + t^M$ and the utility of remaining in the civilian sector as $U^C = W^C + t^C$, where W^M and W^C are the military wage and civilian wage respectively, and where t^M and t^C are the non-pecuniary aspects of employment. From an economic standpoint, they hypothesize that individuals will join the military only if the pay differential ($W^M - W^C$) exceeds the net preference for civilian life, $t = t^C - t^M$.

that continuation rates jumped from approximately 90 percent at 10 to 13 years service to 95 percent at 14 to 19 years of service. Macken, et al. (2002) found further evidence of this type of retirement pull behavior in the continuation rates of Surface Warfare Officers in the United States Navy – approximately 94 percent for officers above 10 years of commissioned service.

B. BACKGROUND

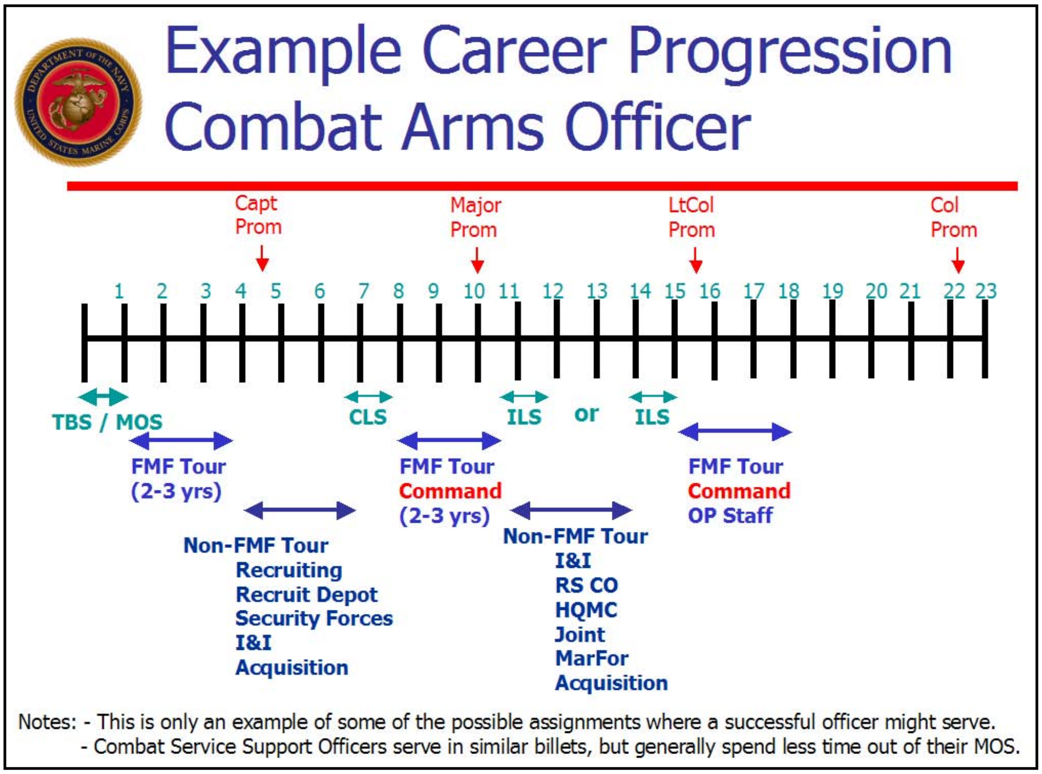
The Marine Corps has a wide variety of mission requirements outside its primary warfighting mission that must be met using available PMOSs. These obligations are for the majority met by employing Marines in alternative assignments outside of their primary occupation – these are known as "B" billets – which encompass all forms of responsibilities from headquarters staff, to recruiting and training recruits on the drill field, to security forces, to joint duty and infrastructure type base operations.

For successful careers in the Marine Corps, USMC officers are told in general that they should show diversity in their careers while maintaining PMOS proficiency. The basic career path that is often espoused is: to serve in the PMOS, followed by serving a "B" billet tour, followed by attending professional military school. This path should then be repeated. This can be seen in Figure 1 as Fleet Marine Force (FMF) tours, non-FMF tours, and schools – career level school (CLS) and intermediate level schools (ILS).

There is not always an opportunity to follow the basic path from PMOS to "B" billet to school. "B" billets are coded for specified PMOSs. The amount of "B" billet availability depends in part on the strength of officers by grade in the assorted PMOSs. Thus, if an officer is in a traditionally "short" PMOS—there are not enough officers in that PMOS to meet all requirements—then "B" billet assignments are not normally available or availability is very limited. Although monitors—officers who assign Marines to new billets—do consider preferences for duty, they must first take the needs of the Marine Corps into consideration to maintain or achieve combat readiness.

On the other hand, many USMC officers prefer to remain in FMF unit assignments—the pointed end of the spear—as opposed to serving in "B" billets. They

Figure 1. Example Career Progression Combat Arms Officer



(Source: From HQMC, M&RA, MMOA-4, Officer Career Counseling, 2005)

did not join the Marine Corps to carry out administrative type jobs behind a desk—the majority of "B" billets are found at Headquarters Marine Corps, and on recruiting; however, if officers fail to serve in "B" billets away from their PMOSs, it may show that those officers are less “rounded.” Again, PMOS shortages may make broader assignments for some occupations impractical. It is important to note that officers can be assigned to many billets within their PMOSs that are not FMF assignments, making the ratios for PMOS and FMF different.

It is important for officers to show billet success both within the FMF and in billets in non-FMF assignments, but it can be questioned whether this meets the needs of the Marine. Successful tours in all billet assignments should result in promotion; however, after the initial obligated active service of four years for ground MOSs for officers with a reserve commission, five years for officers with regular commissions, six years for helicopter pilots and navigators, and eight years for fixed-wing pilots, the decision to remain on active duty is the officer's. The perceived quality of assignments

and whether personal needs for joining the military are being met may have a strong impact on retention.

The goal of the Marine Corps officer promotion process is to select the best and fully qualified officers to continue to fill more senior positions based on past performance of duty. The quality of an officer is based on high levels of performance over a wide range of assignments and levels of responsibility as well as other factors. One factor that makes officers competitive for promotion is diversity in their careers. In a future orientation, the promotion process is executing a five-year plan drafted by Manpower Plans and Policy. However, in a present orientation, the Officer Assignment Branch must assign officers based on the priorities listed in the Marine Corps Personnel Assignment Policy directive; i.e., in descending order, 1) needs of the Marine Corps, 2) MOS/billet variety, 3) individual availability, 4) overseas control date, 5) seniority, and 6) individual preference. The needs of the Marine Corps may have a more profound effect on officers in short strength PMOSs.

According to the Marine Corps Officer Promotion Manual, PMOSs are critically short when the on board strength is below 85 percent of the requirement, which means that required billets are not being filled. With this demand greater than the supply, the needs of the Marine Corps may trump all the other factors. The result may be that the career diversity seen as important for future promotion opportunities is outweighed by the present need to meet mission requirements.

From an equity frame of reference, it would seem only fair to offer the same service opportunities to all USMC officers regardless of PMOS since all unrestricted ground and air officers compete against one another for promotion. If officers in "short" PMOSs were not afforded these opportunities, it would be reasonable to assume that they would have lower promotion rates. In addition, if early on in officer careers it becomes general knowledge that promotion is dependent on diverse assignments, it would be reasonable to assume a reduced survival rate in these PMOSs.

C. PURPOSE

The purpose of this research is to examine the importance of assignments on the promotion and survival of USMC mid-grade officers. This research will evaluate data

from the Marine Corps Commissioned Officer Accession Career (MCCOAC), and a file of all officer fitness reports from 1980 to 1999, to determine how much of an influence assignments – primary occupation duty, operational duty, and special duty (recruiting, joint, drill field, and security) – have on the promotion to the grade of major of separate occupation specialty groups and the survival of officers in those separate groups to the promotion point of major.

Male, unrestricted, active duty cohorts from each of the fiscal years from 1980 to 1988 will be analyzed. This will provide sufficient data to follow each cohort over an eleven-year period, which is close or exceeds the amount of service needed to be selected for the grade of major. Officers who separate from active duty after their initial obligation will not be analyzed; however, of the officers analyzed, the data will include all active service back to their first fitness report as an officer.

D. RESEARCH QUESTIONS

1. Primary Questions

a. Does the ratio of time served in the primary military occupation specialty (PMOS), over total time served, have a significant effect on the probability of promotion and attrition of USMC mid-grade officers across different PMOS groups?

b. Does the ratio of time served in Fleet Marine Force (FMF) units, over total time served, have a significant effect on the probability of promotion and attrition of USMC mid-grade officers in different PMOS groups?

2. Secondary Questions

a. Is there a significant difference across PMOS groups in the amount of time spent in assignments outside the PMOS?

b. Is there a significant difference in the amount of time spent in the FMF across PMOSs?

c. What other factors have a significant impact on the probability of promotion and attrition?

E. BENEFIT OF THE STUDY

The benefit of this study will be to provide Manpower and Reserve Affairs, Headquarters Marine Corps a better understanding of the effects of assignments of the officer corps on the equity of the promotion process, of the effects of assignments on officer retention, and the ability to better counsel officers in low-density occupations. Furthermore, this study may provide Headquarters an additional explanation as to why certain PMOSs exhibit higher attrition rates and continue to remain chronically under-strength even though flow points should be successful in maintaining an appropriate number of these PMOSs.

F. ORGANIZATION OF THE STUDY

Chapter II will provide a review of relevant literature and related research on assignments, promotion, and retention. Chapter III will explain and summarize the data and provide preliminary statistics on the sample used for this study. Chapters IV will describe the methodology and results of the models used to analyze the data. Chapter V will conclude with a discussion of the findings and limitations of the study, and will recommend areas for further research. Supporting information will be provided in the appendix.

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II. LITERATURE REVIEW

> *A hundred times every day I remind myself that my inner and outer life are based on the labors of other men, living and dead, and that I must exert myself in order to give in the same measure as I have received and am still receiving...*
>
> *—Albert Einstein*

A. OVERVIEW

There have been many studies conducted on both promotion and attrition of officers in the Marine Corps. The studies provide a spectrum of approaches from replications of older studies with newer data, to research on unique aspects that may not have been previously considered. However, there has been little work done in the area of the effect of assignments on promotion and retention.

Most prior studies provide explanatory variables that, given a good source of data, should be used as control variables when attempting a different area of research. The following information is a discussion of previous work relevant to this study. In addition, assignment information, specific to the Marine Corps, will be presented in this chapter to show its applicability to a study of promotion and attrition.

B. PROMOTION

1. Study by Hamm (1993)

Hamm's objective was to determine what variables were associated with success or failure up until promotion to the grade of major. He used data obtained from the Headquarters Master File and combined this with TBS performance data. His data set consisted of over 17,000 observations and followed officer careers from calendar year 1980 to 1991.

Important to note for both promotion and retention, Hamm found that commissioning source, GCT score, and class standing at TBS were significant for both promotion to captain and promotion to major. Specifically regarding his model predicting promotion to major, Hamm found that selection rates did not differ significantly by race.

The main limitation of Hamm's study was a small number of descriptive variables that may have caused bias in his results. Additionally, as shown in the next thesis review, the lack of a performance indicator may also have created an upward bias in his results. The later studies have shown that performance is the single most powerful predictor of promotion.

2. Study by Wielsma (1996)

Wielsma's primary intent was to assess whether higher performance levels were evident for Marine Corps officers obtaining a postgraduate degree since their initial commission. The idea was that promotion and retention are outcomes of performance rather than measures of performance. The dataset used for this study was longitudinal data on a panel of officers who had been accessed into the Marine Corps during fiscal year 1980, and followed their service through fiscal year 1994. The data was compiled utilizing many sources to include data gathered by the Defense Manpower Data Center (DMDC), the Marine Corps Automated Fitness Report System (AFRS), the Headquarters Master File (HMF), and the Official Military Personnel File (OMPF).

Wielsma used a method to create a performance index based on fitness report data to test the hypothesis that officers with graduate education had greater than average performance. He controlled for demographic traits (age, race, gender, married), affective traits (commissioning source, MOS, and prior enlisted service), cognitive skills (GCT, TBS school ranking), and for performance measures (service through major, promotion to major). He used promotion to major as his dependent variable in one series of regressions and an estimation of officers who stayed until the point of promotion to major as another dependent variable. To mitigate potential biases caused by self-selection for graduate programs as well as the decision to stay or leave the service prior to promotion selection, Wielsma conducted the Heckit procedure to create the inverse Mills' ratio.

The conclusion of Wielsma's study was that the average performance index was the most significant variable in predicting promotion. Interestingly, he did not find consistent results for intelligence, commissioning source, MOS, and other demographic variables across models in predicting promotion or retention. Finally, he did find that

officers obtaining a postgraduate degree did have higher performance indices; however, these officers had a lower probability of being promoted.

The main limitation of Wielsma's study was the use of only one cohort for his data sample. More consistent results could be expected if a broader sample of officers were used. Additionally, as he followed the cohort from date of first commissioning, Wielsma did not reduce his sample to officers who served beyond their initial obligations; however, as noted, this selection bias may have been mitigated through the Heckit procedure used. Interestingly, for the stay to promotion model, he did reduce the sample size to just officers that had decided to stay until promotion. His finding that 69 percent of the officers who stayed were promoted, gave credence to his model as the actual promotion rate for the studied cohort was between 67 and 70 percent.

3. Study by Grillo (1996)

The main purpose of the study by Grillo was to predict the selection rate of minorities and females. Many of the same attributes used in the past were adopted in this study except for one key difference – Grillo introduced a variable for promotion board precepts. He found that having a precept for a short PMOS was insignificant in his models. On the other hand, Grillo found that the performance index used was significant. The conclusion made was that these results helped to confirm that promotion selection is based on performance.

The main limitation of this study was that the data sample included only captains in zone for promotion for years 1994 and 1995. Additionally, although fitness report scores were collected over officers' careers to calculate a performance index, the study included a limited number of explanatory variables from a single snapshot in time.

Prior to moving on to the following section, it is important to explain what is meant by promotion precepts and their function in a promotion board. In short, the precept of a promotion board is a lawful document signed by the Secretary of the Navy, which convenes the promotion board. It assigns the members of the board and provides additional guidance to the president and the members of the board.

To connect the promotion process with the manpower planning process, the Marine Corps Manpower and Personnel Policy division of Headquarters Marine Corps provides additional guidance to be published in the precepts of the promotion board. In this way it is possible to shape the future force of the Marine Corps. As part of this guidance, critical shortages of particular PMOS are published in the board precept to indicate that appropriate consideration should be given to officers with these skills when selecting the best and fully qualified officers to meet the Marine Corps needs.

C. ATTRITION/RETENTION

1. Study by Hurst and Manion (1985)

The study by Hurst and Manion predicted the probability of separation from active service. In addition to occupation, pay, and unemployment factors, an index variable for performance was formulated. Opposite of other promotion models, this performance index was used as a proxy to control for officers who lost the taste for the military, as evidenced through low performance scores.

Three major points to take from the Hurst and Manion thesis are in regards to the index created, the information on majors, and the ending conclusions. The index – a desire to stay in the Marine Corps based on performance – was the most significant variable. It was concluded that attrition at higher grades was based on officers' decisions. This conclusion was backed up by a reverse in the sign of the index predictor, at the grade of lieutenant colonel, showing when retirement was no longer an issue that increased attrition was the result of a higher performance index.

Hurst and Manion did use a large data set covering seven years. However, the data was a cross-section and did not follow particular cohorts. This did not allow the researchers to control for individual-specific fixed effects. The main drawback of the study was a lack of significant results for attrition at the grade of major due to insufficient observations; the model could not predict attrition for majors, as the actual attrition for fiscal year 1981 was only four officers. On the bright side, this finding supports the need to follow cohorts to show attrition over a period of time, and to censor data prior to the promotion point of major to study voluntary attrition.

2. Study by Ergun (2001)

It was Ergun's goal to study the effect of officer commissioning programs on retention and promotion to major and lieutenant colonel in the Marine Corps controlling for factors from fitness reports and performance at TBS. The analysis included over 28,000 observations and spanned dates of first commissioning from 1980 to 1999. The data gathered came from the MCCOAC file and the old fitness report file (most likely from the Automated Fitness Report System. The raw data for the current study comes from these same files.

Ergun conducted a thorough investigation of the data available. His study provides an opportunity to use similar variables as controls. It is encouraging that Ergun found commissioning source was indeed significant in predicting attrition. Additionally, his findings showed that marital status, age, TBS ranking, and occupational field were also significant in predicting attrition. However, as opposed to previous studies that used a performance index in predicting attrition, Ergun attempted to explain variations in the performance index using it as the dependent variable.

3. Study by Hoglin (2004)

Hoglin continued research using the MCCOAC file used by Ergun. However, Hoglin opted to use a semi-parametric model – Cox Hazard Regression – to estimate the hazard of attrition; this is also known as survival analysis. This type of analysis does not simplify the dependent variable to retention to a certain point or not. Rather, the survival analysis takes into account the timing of attrition, and as such, provides a better characterization of the process over time. In other words, as time goes on, certain variables will show an increasing likelihood of attrition taking place.

Due to his goal of studying prior enlisted officers specifically, Hoglin could only use data from 1986 to 1999. His findings are difficult to compare directly to other studies as the coefficients resulting from the regression are in a vastly different format. On the other hand, the direction of the predicted variations remain the same; i.e., if a hazard ratio is interpreted as showing a lower hazard of attrition, then officers displaying that characteristic have a lower chance for attrition or a greater chance for retention.

Hoglin found that commissioning source, marital status, and TBS class ranking all had significant effects. An interesting finding not expected was a greater hazard for combat PMOSs over other PMOSs in service support and combat service support. It was hypothesized that due to lower job-skill transferability that the hazard would be lower. A possible explanation of this effect may be seen in the next section on assignments – greater deployments may result in higher attrition.

D. ASSIGNMENTS

1. Study by Long (1992)

In his study, Long analyzed professional and personal characteristics that affected the promotion rates to major, lieutenant colonel, and colonel in the Marine Corps. He used pooled, cross-sectional data on all captains, majors, and lieutenant colonels in the primary zone for promotion from fiscal years 1986 through 1992. Data was obtained from the Management Information Branch, Headquarters Marine Corps (HQMC).

Long used log-linear models to find correlation between variables, with no distinction being made between dependent and independent variables. If zero correlation was found between associated variables then they were discarded. As such, each resulting model for the various grades was different. Once uncorrelated factors were removed, Long developed final models using LOGIT analysis in a categorical step-wise modeling procedure.

Long modeled promotion to the particular grade as a function of race, gender, postgraduate education, occupational field, duty station, general classification test (GCT) score, marital status, combat experience, commissioning source, personal awards, and attendance at appropriate level school (ALS). It was noted in the title of the thesis, but also as a fault in future studies, that controls for performance were not included in his analysis which could have caused an upward bias on his resulting parameter estimates.

Long used the Monitored Command Code (MCC) to determine the duty station where officers were assigned when the promotion board was convened. He subdivided the duty station variable to FMF duty, Non-FMF duty, HQMC duty, Recruiting duty, and duty aboard Quantico, Virginia. In his model predicting promotion to major, Long found

that duty station was indeed statistically significant with Non-FMF duty predicting an approximately three percent greater selection rate over FMF duty; HQMC duty about four percent higher; Recruiting approximately 16 percent higher; and, Quantico duty approximately one percent lower than FMF duty.

There were some limitations to Long's study. The duty station variables he used only described the duty station at the time the promotion board met rather than all of the duty stations spanning an officer's career. He used four variables for PMOS as controls – Combat Arms, Fixed Wing, Rotary Wing, NFO, and Support – but he did not account for time outside of the PMOS. And, as mentioned before, there may have been upward bias in his results due to the lack of a performance indicator.

2. Study by Theilmann (1990) and Study by Zinner (1997)

Theilmann and Zinner both studied the retention of USMC company-grade officers. Both studies were essentially the same – they both used factor analysis to create variables for logistic regression; however, Theilmann's data came from the *1985 DOD Survey of Officer and Enlisted Personnel* while Zinner studied the 1992 survey.

Although interpreting variables created in a factor analysis can be tricky, the parts associated with each factor are normally related. Although the data used by both Theilmann and Zinner is not directly related to the data in this and other promotion and retention theses, there is a noteworthy similarity – the importance of the intrinsic job satisfaction. Both Theilmann and Zinner found that satisfaction with the current job, current work conditions, and acquaintances were highly significant in predicting the retention of junior Marine officers.

3. Study by Hosek, Tiemeyer, Kilburn, Strong, Ducksworth, and Ray (2001)

Hosek, et al, conducted a study on minority and gender differences in the military officer career progression. The research was conducted from 1994 to 1996 to study equal opportunity. The study followed officers from first commissioning to the grade of O-6 (colonel/captain) in seven cohorts. These seven cohorts included first commissioning in 1967, 1970, 1977, 1980, 1983, 1987, and 1991. The data set used for the study included

officers from all services. In addition to data from the Defense Manpower Data Center, the authors also did extensive interviews.

The specific topic of this study is beyond the scope of the current study due to limited data on minorities and females in the Marine Corps officer ranks. However, like the previous studies by Theilmann and Zinner, there was some compelling information regarding assignments Hosek, et al, introduced a descriptive variable not seen in other studies. By working with duty occupations, they determined a category for non-occupational assignments. These assignments indicated service outside of the PMOS.

As support for the current study, it was found in both promotion to O-3 (captain/lieutenant) and to O-4 (major/lieutenant commander) that service in non-occupational assignments was associated with reduced promotion under executive, tactical, engineering, supply, and administration. All the same, it is unclear how the variable was constructed; i.e., whether this represented service just prior to promotion or at some other point in the officers' careers.

4. Study by Fricker (2002)

Fricker conducted a study for RAND that looked at the effects of personnel tempo on officer retention in the U.S. military. What makes this study unique from the others is the attempt to show causality between high deployment and lower retention. The study begins with a reminder to the reader that conclusions in the *1999 Survey of Active Duty Personnel* were that the amount of time with family was the second most common reason for leaving active service, and that deployment was the fifth most common reason.

To code for deployment, Fricker used data from officers' records that showed they were receiving Family Separation Allowance and Hostile Fire Pay. This would provide for a measure of the length of deployment and separation from family. Also to find general trends, the data was divided into the early 1990s – pre-1995 – and the late 1990s – post-1995 – with the first period covering the Gulf War, actions in Bosnia and in Somalia, and the later period covering more peaceful times and a leveling out of the Department of Defense drawdown.

Fricker used survival analysis on the mid-grade officers because "mid-grade officers may leave the service at any time," and that the "advantage of survival analysis is that it can handle 'censored' observations" (Fricker, p. 25-26). This allowed Fricker to use all available data up to a specific point in time. If officers were still in the service at that point, then they were censored because there was no data to show if the officers left active service after that or not.

The Fricker study looked at all services in the U.S. military. Thus, generalizations are made as far as overall results. Surprisingly, the study found that more deployment was associated with higher retention, which was opposed to the original hypothesis. The study also found that the overall general results were consistent between the early 1990s period and the later 1990s period. However, in regards specifically to mid-grade Marine Corps officers, the study did find that increased amounts of deployments did result in a decrease in retention.

Although this is a retention study, it is important to note that a predictor for attrition was increased deployments. The comparison with the current study is that the FMF units in the Marine Corps are the ones that deploy – more time spent in FMF units is associated with increased deployment time.

5. Study by Sanchez, Bray, Vincus, and Bann (2004)

This study was similar to Theilmann's and Zinner's; however, it was conducted by a non-military organization – the Research Triangle Institute. This institute mainly conducts studies in social and statistical sciences, science and engineering, international development, and health. The data used in this study came from the Total Force Health Assessment and the Perceptions of Wellness and Readiness. It consisted of over 24,000 records made up of both officer and enlisted, and active duty and reserve personnel from all four military services.

Not many outside studies were found that specifically worked with Marine Corps data. However, this study validates previous findings regarding job satisfaction and its relationship to attrition. Sanchez, et al, found that officers with job-related problems indicated a lower job satisfaction than those who had problems in other life areas. They also found that the most important predictor for low job satisfaction was job pressure.

Although this sounds intuitive, their conclusions were a result of intensive study and regression analysis.

This study provides sound evidence that job assignments are a major factor in predicting employee satisfaction. It can be deduced that low levels of satisfaction leads to retention problems.

E. CONCLUSIONS

The literature provides positive direction on which variables should be taken into account when predicting promotion, retention, and attrition for Marine mid-grade officers. There were some conflicting results in the areas of occupation and demographics; however, this was most likely due to the varying samples used in each study.

How assignments relate to promotion and retention is unclear. The literature provides ample evidence that assignments are influential, but an established methodology for handling this subject has not been distinguished. Long lays the best groundwork in the analysis of duty location, but failed to take into account the duty assignment and how all assignments across years of service affected promotion and retention. Additionally, Fricker's study did show that as deployment time increased, retention if mid-grade Marine officers decreased.

The survey studies showed that there is a relationship between job assignment and satisfaction. Satisfaction appears to be a factor in retention and may influence promotion through higher performance indices. This adds more to the foundation to the current area of research; however, at this time, it can only be assumed what effect a percentage of time served outside the primary occupation, what effect a percentage of time served in the operational forces, and how this differs across occupations has on promotion and retention.

III. DATA AND PRELIMINARY ANALYSIS

No tool is of any use unless we know what we're building with it. Once we see where we're going, we have a concrete basis for choosing the methods that are most effective to help us move toward our goal.

—Father Laurence of the Monks of New Skete

A. DATA SOURCES

Two sources of data were used in this study, the Marine Corps Commissioned Officer Accession Career (MCCOAC) file and the Marine Corps Officer Fitness Report file. Quester and Hiatt (2001) consolidated information from several sources to create the MCCOAC file. The file consists of data on all Marine Corps commissioned officers who attended The Basic School from 1980 to 1999. Headquarters Marine Corps provided the fitness report file for all commissioned officers who had received fitness reports from the late 1950s through 1998—the point at which the Marine Corps changed to the new fitness report.

The MCCOAC and fitness report files were merged into one file after correcting for missing and clearly miscoded data. The result was a single observation, with multiple characteristics, for each officer who had accessed into the Marine Corps as a second lieutenant from the years 1980 to 1989. These observations were coded into 10 distinct cohorts based on the fiscal year of commissioning. Descriptions are included in Table 1.

B. VARIABLE DESCRIPTIONS

A basic description of each variable used in this analysis can be found under Table 1 on the following page. The paragraphs following this table provide a detailed explanation of the variables and the methods used to create, code, and fix mistakes found in the original data files.

Table 1. Variable Description

Variable	Variable Description	Variable Type
Dependent		
Prom_O4	Promotion to major	Binary
Stay	Stay to 120 months commissioned service	Binary
Duration	Quarters of commissioned service at attrition	Continuous
Assignment		
FMFRatio	Ratio of FMF days over total days	Continuous
$(FMFRatio)^2$	Square of FMFRatio	Continuous
PMOSRatio	Ratio of PMOS days over total days	Continuous
$(PMOSRatio)^2$	Square of PMOSRatio	Continuous
Combat	Has received a combat fitness report	Binary
Joint	Has received a joint fitness report	Binary
MSGMCSF	Has served in a security guard/force billet	Binary
Drill	Has served in a drill field billet	Binary
RSOST	Has served in a recruiting billet	Binary
Performance		
PI	Mean of all fitness report attribute scores	Continuous
TBSPerc	Percent of TBS class ranking	Continuous
Top_Third	Top third in TBS class ranking	Binary
Mid_Third	Middle third in TBS class ranking	Binary
Bot_Third	Bottom third in TBS class ranking	Binary
Occupation		
MOS_Combat*	Combat primary occupation	Binary
MOS_GrndSupt*	Ground Support primary occupation	Binary
MOS_AirSupt*	Air Support primary occupation	Binary
MOS_Service*	Service primary occupation	Binary
Commissioning		
PLC	Platoon Leaders Course	Binary
OCC	Officer Candidates Course	Binary
NROTC	Naval Reserve Officer Training Corp	Binary
USNA	United States Naval Academy	Binary
ECOMM*	Enlisted Commissioning Program	Binary
Demographics		
COMM_AGE	Age at time of commissioning	Continuous
PRENL	Prior Enlisted Service	Binary
Gender (Male)	Sample contains only male officers	n/a
Married	Self explanatory	Binary
White	Self explanatory	Binary
Black	Self explanatory	Binary
Hispanic	Self explanatory	Binary
Other Race*	Self explanatory	Binary
Fiscal Year		
FY80 to FY89	Control variable for fiscal affects	Binary

(Source: Author)
*Complete variable descriptions to follow.

1. Dependent Variables

Three dependent variables were used in this analysis—promotion to major, stay to the promotion point of major, and duration of months of commissioned service. Due to different career paths pilots, naval flight officers (NFO), and lawyers were removed from the sample.[3] Additionally, due to restrictions of service in many PMOSs and the low percentage of observations in this sample, the careers of female officers were not analyzed.

a. Promotion to Major

This variable was restricted to individuals who began their careers as second lieutenants and had a career path through each grade, which could be positively identified in the data file by dates of rank. Observations that included a date of rank to major were given a value of '1' for promoted. Observations without a date of rank to major were given a value of '0' for not-promoted.

b. Stay

Past studies have presented findings to show the promotion rate to major from new accessions. However, due to contract lengths, augmentation from reserve to regular commissions, and personal taste choices to stay or leave the Marine Corps, a better measure of how career characteristics influence promotion to major would be to restrict the dependent variable to just those individuals who were seen by the promotion board. Therefore, the variable STAY was created to indicate whether the officer stays up to the promotion point or leaves at some time prior to that point.

The promotion to major variable used in this study was restricted by using the "stay" variable. This was calculated separately, for each cohort, by analyzing the mean number of months to promotion for each cohort and backing off three standard

3 Pilots have contracts from six to eight years depending on aircraft and year of accession. Naval flight officers (NFOs) also have contracts of five to six years. Pilots and NFOs have also had the opportunity to elect aviation bonuses. This can cause a downward bias in results for promotion as more aviators may stay on active duty and be seen by the promotion boards. It can also cause a downward bias in attrition models as these officers stay longer than their ground officer counterparts.

Lawyers follow a different career path as many who have already finished law school begin their careers as first lieutenants. Variables, which affect both promotion and retention may, have a different effect on this group of officers. More importantly, as many of the variables are dependent on the amount of months of commissioned service, these officers would fall outside the window of promotion points of other ground officers (not based on seniority, but rather months of commissioned service).

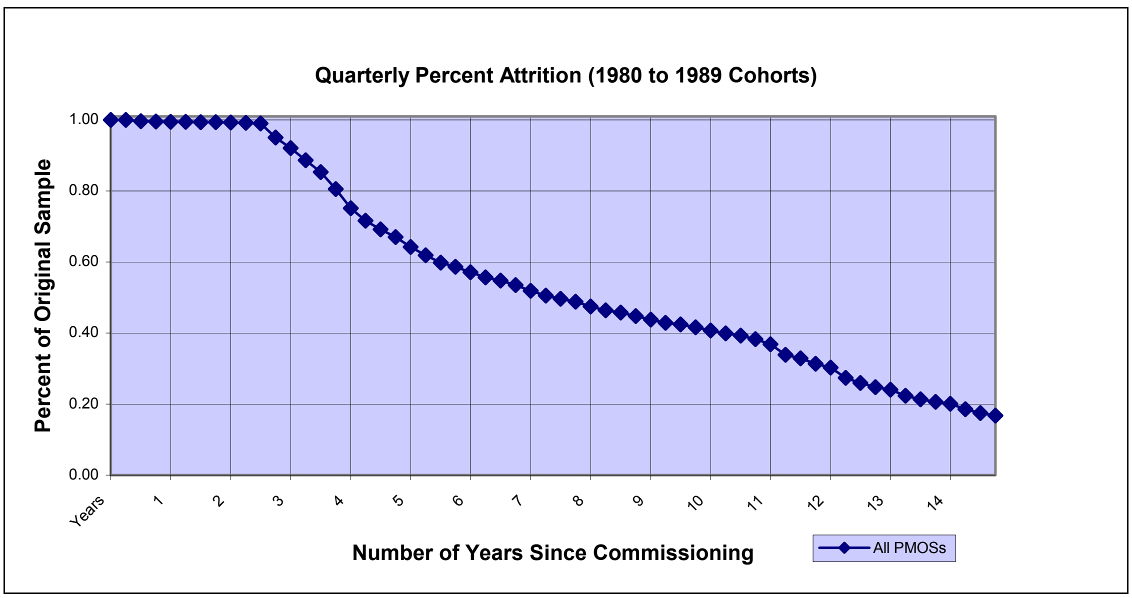
deviations. This way, the promotion to major dependent variable only included those officers still on active duty at the time each promotion board was convened.

c. Duration

To be able to conduct a survival analysis, a duration variable had to be constructed. In the case of Hoglin's thesis, the data was censored at a fixed point in time. A different method was used in this study.

Rather than censoring at a fixed point in time, each cohort was observed over a 10 year period. The duration variable for this study was created by giving a duration value for each three month period of commissioned service, measured by the MCCOAC variable "number of months." This is graphically represented in Figure 2—the points on the graph represent the percentage point drop in officers, for each quarter, from the month of first commissioning to 15 years of commissioned service.

Figure 2. Quarterly Percent Attrition (All PMOSs)



(Source: Author – developed from MCCOAC data file)

This allowed not only a study of survival of Marine Corps officers, but also more specifically, a study of the period after promotion to captain and before promotion to major for each cohort. As with the stay variable, this method removes bias from the survival analysis due to forced attrition (on the lower limit, failure for selection to captain, or failure to augment into the regular Marine Corps; and on the upper limit, failure for selection to major). This method also removes bias due to forced retention—

up to the five year mark for U.S. Naval Academy (USNA) graduates and full scholarship Naval Reserve Officer Training Corps (NROTC) (recall that pilots and NFOs with longer contracts were already removed from the sample). What was left is a five year period, from five to 10 years of commissioned service, over which it was an officer's choice to remain in service or resign.

2. Assignment Variables

The assignment variables are the first of the independent variables. As discussed in the literature review, there have not been many studies that have used assignment specific variables as indicators for promotion or attrition. The primary variables of interest in this study were FMF Ratio and PMOS Ratio. These variables were constructed from the fitness report file by using the Monitored Command Code (MCC) on each fitness report for the FMF Ratio and the MOS on each fitness report for the PMOS Ratio.

By taking the "from date" and the "to date" on each fitness report, the number of days spent in the FMF and the number of days spent in the PMOS were calculated. If, according to the Marine Corps Codes Manual, an MCC was not considered an FMF assignment, then those days were not counted. Using the same rationale, if the MOS listed on the fitness report was not a PMOS—signifying that the officer was serving in a "B" billet—then those days were not counted. The denominator for each variable was constructed by taking the first "from date" on the first fitness report as a second lieutenant, and subtracting it from the last "to date" on the last fitness report as a captain.

It is important to note a couple items regarding these variables. No MCC codes were recognized as miscoded; however, if a PMOS was obviously miscoded, such as "U4U2" vice "0402", then these data points were recoded with a corrected MOS. Additionally, the FMF Ratio and the PMOS Ratio are distinct variables; i.e., an officer can serve in a "B" billet outside of the PMOS while still serving in the FMF. Vice versa, an officer can serve in a PMOS and not be assigned to the FMF. To check this statement, a correlation test of these two variables was conducted, which showed no significant correlation.

Finally, in creating these variables, it was hypothesized that too much of either the FMF Ratio or the PMOS Ratio would cause issues in an officer's career—if an officer spends the majority of time in the FMF or in the PMOS, then the officer lacks diversity from a promotion board standpoint. From an attrition standpoint, as discussed earlier in the literature review, Fricker noted that high operation tempo caused reduced retention in mid-grade Marine Corps officers. A high FMF ratio greatly increases the likelihood of increased operation tempo. In the same vein, a high PMOS ratio may cause weariness without opportunities for work broadening experiences, especially in less desirable occupations.

To account for the possibilities above, the square of the FMF Ratio and PMOS ratio were constructed. When these quadratic variables are used in conjunction with the linear variables, it will assist in ascertaining if higher ratios do in fact decrease promotion and increase attrition, and at what point this occurs—using simple calculus, the turnaround point of the curved relationship between these variables and the dependent variable can be determined. A major point is that the inclusion of the square terms allows for the effects described above to be non-constant and diminishing in magnitude.

The remainder of the assignment variables were constructed as dummy variables to account for the effect of having served in combat, on joint tours, on Marine Security Guard or Marine Corps Security Forces tours, on the drill field, and in recruiting billets. Combat and Joint tours were identified by using the fitness report flag of duty type. The other variables were identified by using the MCC codes found on the fitness reports for service in those tours.

3. Performance Variables

In nearly all of the literature reviewed, performance was by far the most important variable in explaining promotion and it was also important in explaining attrition. To account for this, and to ensure a control for performance when studying other variables, a performance index was calculated. The process followed Wielsma's methodology with only minimal modifications.

Essentially, the 22 professional and personal characteristics, found on the old fitness report, were coded for each fitness report received from second lieutenant to

captain on a quantitative scale (not observed = missing, unsatisfactory = 1, below average = 2 average = 3, above average = 4, excellent = 5, and outstanding = 6). The result was a performance index for each observation for each officer grade. To ensure that missing values did not cause lower indices, the mean was taken over all the existing non-missing values. The final performance index was created by taking the mean of the performance index of each officer grade. Thus, even for officers who had attrited, the resulting index could be used as a single variable, per observation, for survival analysis.

Other performance variables included the percent overall class ranking at TBS, and which third of TBS—top, middle, or bottom—in which the officer had graduated. TBS class ranking was constructed as an indication of ability and level of acculturation. The value for the variable was calculated by taking the overall class ranking divided by the class size. A variable that classified each officer into a TBS third was located in the MCCOAC data file. Dummy variables were constructed to indicate in which third the officer graduated.

4. Occupation Variables

The original intent was to use each separate officer PMOSs to see if there were effects that had been hidden in previous studies due to grouping of occupation variables. However, although this study covered 20 years of data and followed 10 cohorts, sample sizes still presented problems for accurate analysis. Therefore, Wielsma's grouping categories were selected with minor changes. A dummy variable for each group—Combat MOSs, Service MOSs, Ground Support MOSs, and Air Support MOSs—was created. Table 2 on the following page provides a breakdown of which specific occupations were coded into which MOS groups.

5. Commissioning Source Variables

The commissioning source variables used in this analysis included Platoon Leaders Course (PLC), Officer Candidates Course (OCC), Naval Reserve Officer Training Corp (NROTC), United States Naval Academy (USNA), and a grouping of enlisted commissioning programs—Enlisted Commissioning Program, Meritorious Commissioning Program, and Marine Enlisted Commissioning Education Program—

identified as ECOMM. Although an "other" category existed in the data, the sample size was too small for accurate analysis. These observations were deleted from the sample.

Table 2. Occupational Community Variable Composition

Variable	Occupation Field	Description
COMBAT	03XX	Infantry
	08XX	Artillery
	18XX	Tank and Assault Amphib
SERVICE	01XX	Personnel and Administration
	34XX	Auditing, Finance and Accounting
	43XX	Public Affairs
GROUND SUPPORT	02XX	Intelligence
	04XX	Logistics
	06XX[a]	Data and Communications
	13XX	Engineer
	26XX	Signals Intelligence
	30XX	Ground Supply
	35XX	Motor Transport
AIR SUPPORT	60XX	Aircraft Maintenance
	66XX[b]	Aviation Supply
	72XX[c]	Air Control and Support

(Source: Wielsma Thesis (1996), modified)
a HQMC combined 25XX Communications and 40XX Data Systems into 06XX
b HQMC changed aviation supply designator from 3060 to 6602
c HQMC combined 72XX Air Control and 73XX Air Traffic Control into 72XX

6. Demographic Variables

Standard demographic variables were coded to include marital status, race, and age. Marital status at the time of captain was used to ensure the most applicable effect of that variable at the time of promotion to major. For the survival model, marital status at time of separation was used. The age variable was measured for each observation at the

time of commissioning. If age was missing in the file, commissioning age was constructed using the officer's date of birth.

Due to small sample size, the race variable was coded as white, black, Hispanic, and other race. Gender was not applicable—due to small sample size of female officers only male officer careers were analyzed. Although not traditionally used as a demographic variable, prior enlisted status was included in this section. Coding for this variable did not account for highest enlisted grade, but rather enlisted service only.

7. Fiscal Year Control Variables

There are other factors not available or beyond the scope of this study which may have provided a clearer picture of each individual cohort. However, the point of this study was to show trends across the 10 officer cohorts. A fiscal year variable was created for each observation, based on the fiscal year of commissioning, to control for any year specific factors not included in the data set.

C. SAMPLES USED

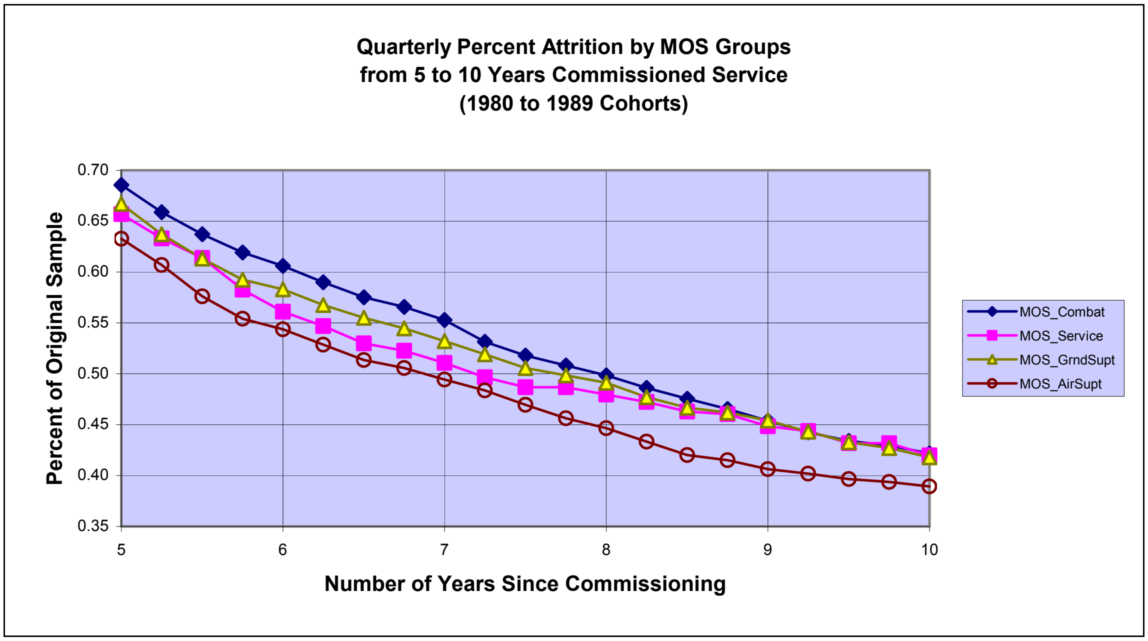
One data sample was constructed for use in this study. Cohorts for each fiscal year from 1980 to 1989 were created. Any observations in the final data set consisted of officers who had entered service as a second lieutenant, and no information was used past the promotion point of major. All of these cohorts were merged into one data set, and fiscal year variables were created to account for differences across cohorts.

Out of the one data sample two subsets of data were created. The basis for each sample comes from Figure 2, which showed the overall attrition of officers in the data set. Figure 3 on the following page provides a more exact picture of attrition across PMOS groups in the range from five to 10 years. As provided in the discussion of dependent variables, the promotion model used only those officers who were on active duty when the promotion boards to major convened. Similarly, the survival model only used observations from officers on active duty from the five to 10 year mark.

There are two supplementary notes to make regarding the data samples. Although a subset of the data was used in each analysis, the observations included officers' career information back to the point of commissioning. Additionally, while Figure 3 shows

differences between the MOS groups, the percentage point drop for each group during this period was essentially the same.

Figure 3. MOS Group Quarterly Percent Attrition (5 to 10 Years)



(Source: Author – developed from MCCOAC data file)

D. PRELIMINARY ANALYSIS

Prior to describing the methods used for analysis, the model development, and the results of the analysis, this section will provide the basic statistics on variables used in this study for later reference. Table 3 on the following page includes the number of observations for each variable, the mean, the standard deviation, and the hypothesized effect of each variable. As many of the variables are binary, the mean value shown equates to the percentage of observations for which the variable has a value of '1.' Rather than go through all of the variables again, just a few items of interest will be noted in the summary of this chapter.

E. SUMMARY

This chapter explained the data files used to create the data file used for analysis—the MCCOAC file from CNA and the old fitness report file from HQMC. The resulting sample consisted of 8956 commissioned officers who were commissioned from fiscal years 1980 to 1989, had begun their careers as second lieutenants, and progressed

normally through the promotion system. Due to small sample size and different career tracks, pilots, NFOs, lawyers, and females were removed from the sample.

Table 3. Variable Descriptive Statistics

Variable	N	Mean	Standard Deviation	Hypothesized Effect (promotion)	Hypothesized Effect (stay)
Dependent					
Promotion to major	2713	0.303	n/a	n/a	n/a
Stay to 120 months	3698	0.413	n/a	n/a	n/a
Quarters service at attrition	5254	21.270	7.931	n/a	n/a
Assignment					
Ratio of FMF days	8956	0.467	0.208	+	+
Square of FMFRatio	8956	0.262	0.200	–	–
Ratio of PMOS days	8956	0.586	0.192	+	+
Square of PMOSRatio	8956	0.380	0.214	–	–
Combat fitness report	2758	0.308	n/a	n/a	+
Joint fitness report	609	0.068	n/a	n/a	?
Security billet	788	0.088	n/a	n/a	+
Drill field billet	886	0.099	n/a	n/a	?
Recruiting billet	716	0.080	n/a	n/a	–
Performance					
Performance Index	8915	5.758	0.250	+	+
TBS class ranking (%)	8956	0.484	0.292	+	n/a
TBS Top Third	2808	0.314	n/a	n/a	+
TBS Middle Third	2897	0.324	n/a	n/a	Base
TBS Bottom Third	3237	0.362	n/a	n/a	–
Occupation					
MOS_Combat	3824	0.427	n/a	n/a	Base
MOS_GrndSupt	3573	0.399	n/a	n/a	–
MOS_AirSupt	1137	0.127	n/a	n/a	–
MOS_Service	420	0.047	n/a	n/a	–
Commissioning					
PLC	3277	0.366	n/a	Base	Base
OCC	1889	0.211	n/a	+	–
NROTC	2006	0.224	n/a	–	+
USNA	967	0.108	n/a	–	+
ECOMM	734	0.082	n/a	–	+
Demographics					
Age at commissioning	8955	23.049	1.944	+	+
Prior Enlisted Service	797	0.089	n/a	n/a	–
Gender (Male)	8956	1.0	n/a	n/a	n/a
Married	4952	0.553	n/a	+	+
White	7845	0.876	n/a	Base	Base
Black	609	0.068	n/a	–	?
Hispanic	250	0.028	n/a	–	?
Other Race	250	0.028	n/a	+	?
Fiscal Year					
FY80 to FY89	8956	*	n/a	?	?

(Source: Author)

* The frequency of officers from each fiscal year varied from 483 in FY1980 to 1343 in FY83. The average was approximately 900.

The descriptive statistics in Table 3 provides a general idea of what happened in this sample of officers. From the original sample, 2713 officers were promoted to major; however, only 3698 remained in service long enough to be seen by the major's promotion board. This selection rate of 73.36 percent is just a little over one percent of the average promotion rate during the time this sample of officers was in zone for promotion.

Of the original sample, 5254 officers did not stay in service long enough to be seen by the major's promotion board. Of these officers, 2051 stayed in service beyond the five year mark—beyond the forced attrition of promotion and augmentation—as depicted in Figure 2 and Figure 3. The average attrition time for these officers was just slightly over the seven year mark, with a standard deviation of 18 months.

The main factors of interest in this study are the influences of assignments. Predictions will be made in the following chapter using various multivariate regression techniques; nonetheless, the descriptive statistics do provide a basic picture. Namely, the average ratios of FMF and PMOS days to career days from second lieutenant through captain were 46.7 percent and 58.7 percent respectively. Additionally, about 30 percent of the officers had combat fitness reports, and only from seven to 10 percent had billets on joint tours, on the drill field, in recruiting, and in Marine Security Guard or Marine Corps Security Forces billets.

The other variables in Table 3 provided controls so these factors above could be more accurately studied. When appropriate, these factors will be discussed in the following chapters. Likewise, the hypothesized effects above will be further elaborated in the following chapter.

IV. MODELS AND RESULTS

> *The progress of Science consists in observing interconnections and in showing with a patient ingenuity that the events of this ever-shifting world are but examples of a few general relations. To see what is general in what is particular, and what is permanent in what is transitory, is the aim of scientific thought.*
>
> *—Alfred North Whitehead*

A. OVERVIEW OF METHODS USED

There are many explanations for methods of analysis from technical and comprehensive to simple and concise. To assist the reader in a better understanding of methods used for this study, only the latter is necessary. A brief description follows of various statistical methods used in this research. Information came from Wooldridge (2003), Fox (2002), and an online manual put together by the National Cooperative Highway Research Program under the National Research Council (2001).

1. Probit

Probit is a binary response model used to explain a relationship between a group of explanatory variables and a discrete dependent variable. The dependent variable often represents a choice or a category. This technique estimates the probability of an event happening—such as promotion—given the independent attributes associated with each observation. Based on the hypothesis, it is presumed that the selected independent variables are associated with or have a causal relationship with the event. The outcome of the Probit gives the level of significance of the association between the dependent variable and the independent attributes selected and the influence of that association. Using Probit also ensures that all probabilities will fall between zero and one. The resulting model predicts changes to the probability of promotion based on the specific attributes introduced in the model.

2. Heckman Correction Procedure

The Heckman procedure is used when there is a potential for selection bias. To correct for selection bias, the Heckman procedure performs a two-stage process, running a regression on a group of variables that must include at least one instrumental variable

not in the second stage model. Instrumental variables those variables that would have some effect on the self-selection but not on the dependent variable of the second stage regression. The second stage uses the output from the first stage, which results in corrected coefficients and a corrected predicted probability that the dependent variable is equal to the tested event; i.e., promotion. The Heckman procedure in this study used Probit in both the first and second stages.

3. Cox Proportional-Hazard

Survival analysis examines and models the time it takes for events to occur. David Cox presented a proportional-hazards regression in 1972 which enabled a better study of survival data. Given a period of time, and measuring a certain event—attrition for example—across that time period, the model predicts what can be expected in the future based on observations having particular characteristics. Although often used in the medical field with the salient feature being survival beyond a certain point—studying the likelihood of surviving given selected treatments and personal attributes—the method can be more generally defined as event-history analysis.

The results of the Cox regression are explained by Fox (2002) as an expression of the hazard for a particular subject "relative to the cumulative hazard for all subjects at risk at the time that the event occurred to [the] subject." Therefore, the model changes over time based on an accumulation of events rather than a simple examination of whether an event happened or not. Thus the time events happened is considered in the Cox regression.

Since this type of regression focuses on the distribution of events over time, it has an advantage over the previously discussed Probit. The dependent variable in a Probit is based on something occurring or not without regard to the time the event happened. In other words, Probit will describe the probability of an event happening by a certain point, but the Cox regression will use the information of when an event occurred for each observation, what characteristics each observation had at the time of that event, and how each of those characteristics could predict the event happening in the future.

The results form the Cox regressions will be presented as hazard ratios. Variables with hazards below one are interpreted as a percentage change from the base hazard that

the event is less likely to happen, while hazards above one predict a greater possibility that the event will happen.

C. PROMOTION MODEL

The Marine Corps has an up-or-out policy. If an officer twice fails to select for promotion to captain or major, then they are forced to attrite, unless previous time served in the military puts them in a safety zone. Although the shapes can differ greatly between each of the PMOSs, each occupation group looks like a pyramid—in a few odd cases, there are less lieutenants than captains creating an outward bulge, but after that point each succeeding grade has less personnel than the previous one.

The motivation behind estimating promotion models is to see what factors have a significant effect on promotion. In this way, force planners can more accurately predict and shape future manpower. Additionally, occupation field sponsors and career counselors can assist officers in attaining a desirable career path that would include promotion.

1. Model Development

It is evident in the literature reviewed that there are common characteristics which have been used to predict promotion. The model specification used by Hoglin was adapted from many past studies on promotion and retention. Additions were made based on what factors were of interest; i.e., Wielsma's intent was to describe the effect of graduate education.

Generally, the variables primarily used can be grouped into commissioning source, career characteristics, and personal characteristics. Commissioning source is self-explanatory. Career characteristics have included performance indicators, information about TBS class ranking, PMOS, prior enlisted status. Personal characteristics have included gender, age, marital status, and age. Therefore, a very basic model for promotion can be described as follows:

$$\mathbf{P(promotion = 1|x) = \mathit{f}(commissioning\ source,\ career\ characteristics,\ and\ personal\ characteristics)}$$

The main factors of interest in this study are assignment characteristics. These type of descriptive variables, fit well under the 'career characteristics' category. What remains is a control for fiscal year specific characteristics. Dummy variables for each fiscal year should control for non-random year-specific events that had an effect on promotion, but were not included in the model.

2. Hypothesized Effects

What is left to discuss, prior to analysis, are the hypothesized effects of each of the explanatory variables. Table 3, in the last chapter, provided an outline of the possible effects these groups of variables would have on promotion to major.

There is not a lot of evidence of assignments being used in promotion studies, except for Long. Although he found that the assignment at the time of promotion to major was indeed significant, this did not explain what effect the career path, or range of assignments over an officer's career, had on promotion. Regarding the ratios created for this study, it can be assumed that more time in the operating forces and more time in the PMOS would both improve promotion rates. However, this does not account for career diversity. The Marine Corps promotion process is designed to select the "best and fully qualified."

Going back to the career path provided in Figure 1, under the background in chapter one, there appears to be a benefit of both PMOS, and non-PMOS time, as well as FMF, and non-FMF time. To find the proper mix, quadratic forms of the PMOS and FMF ratio were calculated. Adding these variables to the model specification permits a possible turn-around point—a point at which too much PMOS or FMF time begins to have a negative effect on promotion.

The other assignment variables, flags for combat, joint, recruiting, drill, and security, would signify diversity in the officer's career. These variables give the promotion board a chance to view how well an officer performs in duties outside the PMOS. The assumption is when controlling for other factors, that these flags should have a positive effect on promotion.

Two other career characteristics are performance on the job and performance at TBS. The performance indicator was shown to have the greatest impact on promotion. It is safe to say that the higher the performance index, the higher the expected promotion probability. As for the TBS class ranking, an assumption is that by the time an officer is in zone for promotion to major, this would no longer have an effect. However, TBS class ranking may indicate ability. Literature reviewed for this study showed evidence that TBS ranking was a predictor for promotion, with top third class rankings outperforming bottom third class rankings.

Another career characteristic not yet discussed is PMOS. Interestingly, although there has been a strong desire to use occupation groups in past promotion models, often times the results come back insignificant. Returning to "best and fully qualified," and the fact that officers in all unrestricted PMOS compete against one another for promotion, there should not be a difference as far as the promotion board is concerned. A review of promotion statistics over the last 15 years does not show a trend against any particular PMOS. This is not to say that PMOSs do not contribute explanatory power for officers' careers, but it is to say that they are most likely more appropriately used in attrition vice promotion models.

The effect of certain commissioning programs on promotion has been mixed. Wielsma found that USNA accessions in his sample had higher promotion rates. Ergun found the OCC graduates had the higher promotion rates over NROTC accessions—other commissioning sources were found to be insignificant. As the data used in this study was also used in Ergun's study, similar results can be expected.

The final variables are personal characteristics. The literature has shown that both age and marital status have a significant effect on promotion. Ergun, found that prior enlisted status also had a positive effect. Although probability of promotion due to race variables has been specifically studied in the military, the percentages of minority races in the studied sample are very small, thus a prediction of the effect of race is difficult; however, within the literature reviewed, it was predicted that minorities had lower promotion rates.

3. Model Analysis and Results

Four different models were constructed to test the effects of assignments on the promotion of officers to the grade of major. The first two models, Table 4 below, tested the effect of the descriptive variables on the promotion probability for officers who had stayed to the promotion point of major—if officers had attrited prior to 120 months of commissioned service, they were not included in the sample.

The main variables of interest were the effects of the PMOS ratio, the FMF ratio, and other assignment flags. The difference between model (1) and model (2) was the introduction of square terms—quadratics—for the PMOS and FMF ratios. Due to its reported importance in previous studies, a performance indicator was added to these models as well. The base case for all models, unless otherwise noted, was a single, white, PLC graduate.

a. Model (1) – Promotion to Major: PMOS and FMF Ratios

Table 4 on the following page shows the results of running a Probit regression on the data set prepared for this study. Of a sample of 3681 officers, who had stayed until the promotion point, the overall predicted probability of promotion was 76.1 percent. Significant effects were found in the assignment ratios, the performance indicator, commissioning source, and the TBS class percent ranking.

Of the assignment variables studied, the FMF ratio was significant at the five percent level. Although the partial effects are listed under Table 4, a cursory glance does not reveal all the details—further calculations for continuous variables such as the FMF ratio must be made. The percent change in probability of promotion depends on the change in the value of the variable studied, and the overall predicted probability of the model.

Since the FMF ratio is measured on a continuous scale from 0 to 1, an interesting finding would be to see what the effect of serving an additional FMF tour would have on the predicted probability of promotion. Assuming the FMF tour adds two years, or 730 days, then the FMF ratio over 10 years of service would increase by 0.20. Thus, this equates to the comparison of an officer with 40 percent FMF time to an officer with 60 percent FMF time.

To find the percent increase in the predicted probability of promotion, the partial effect was multiplied by this change and then divided by the overall model predicted probability (0.76)—in this example, all else equal, the model predicts a 3.2 percent increase in the predicted probability of promotion to major for an officer whose FMF ratio was 60 percent vice 40 percent, due to the additional FMF tour.[4]

Table 4. Probit Estimates of Promotion to Major

	PROMOTION TO MAJOR (1)		PROMOTION TO MAJOR (2)	
	Probit coefficients (1)	Partial effects (1)	Probit coefficients (2)	Partial effects (2)
PMOS RATIO	-0.085 (0.147)	-0.026	2.022 (0.818)**	0.626
PMOS SQ	___	___	-1.729 (0.674)**	-0.535
FMF RATIO	0.387 (0.151)**	0.120	2.013 (0.542)***	0.623
FMF SQ	___	___	-1.859 (0.578)***	-0.575
PI	4.869 (0.249)***	1.510	4.799 (0.250)***	1.485
OCC	-0.093 (0.073)	-0.029	-0.073 (0.073)	-0.023
NROTC	-0.310 (0.065)***	-0.101	-0.314 (0.065)***	-0.102
USNA	-0.396 (0.085)***	-0.135	-0.397 (0.085)***	-0.135
ECOMM	-0.485 (0.081)***	-0.167	-0.457 (0.082)***	-0.156
TBSPERC	0.207 (0.094)**	0.064	0.180 (0.094)*	0.056
MARRIED	0.005 (0.052)	0.001	0.006 (0.052)	0.002
BLACK	0.044 (0.101)	0.013	0.040 (0.101)	0.012
HISPANIC	0.223 (0.159)	0.064	0.226 (0.160)	0.064
OTHER RACE	-0.105 (0.152)	-0.034	-0.116 (0.152)	-0.037
FY CONTROLS	Yes		Yes	
Constant	-27.523 (1.403)***		-27.995 (1.423)***	
Observations	3691		3691	
log likelihood	-1789.600		-1779.927	
Pseudo R2	0.162		0.167	
$P(\hat{Y} = 1)$		0.761		0.762

(Source: Author)
Note: Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

[4] Calculation as follows: 0.12*(0.60–0.40)/0.76 = 0.032

Using similar calculations as above, all else equal, the percent change in predicted probability of promotion for an officer whose performance indicator (PI) increases by 0.1 (the scale for the PI is 0 to 6, but the majority of values fall between 5.5 and 6.0), would be 19.7 percent. Thus, this study provides similar results to previous studies with regard to the large impact that the PI has on promotion.

Other interesting results come from commissioning source. Since the commissioning sources were coded as dummy variables, the partial effect would be compared to the base case—PLC graduates for this study. According to this model, the results predict all commissioning sources have a lower probability of promotion, with NROTC having the smallest estimated effect, a 0.101 decrease in predicted probability of promotion, and enlisted commissioning programs having the largest estimated effect, a 0.167 decrease.

b. Model (2) – PMOS and FMF Ratios with Squares

Model (2) has one major difference over model (1)—the introduction of squared terms. These variables were included to see if the PMOS and FMF ratios had a curvilinear effect vice a linear effect on the predicted probability of promotion. The first interesting point to note, when the squared terms were added, was that the PMOS ratio became significant and the FMF ratio became more significant. The significance of all other variables remained the same.

A most interesting aspect would be to find the turnaround point of these ratios—note in the results for model (2) the effect of the linear term is positive, but the effect of the squared term is negative. In this case, model (2) more accurately predicts that officers with a PMOS ratio greater than 0.585, or an FMF ratio greater than 0.542, will have a decrease in probability of promotion to major all other variables equal.[5]

To find out the percent decrease in predicted probability using these squared terms, the first derivative must be used again, but with a modification. Here it was necessary to add the starting point of what change was being considered and the amount of that change. For instance, knowing the turnaround points for the ratios, let us

[5] When $y = \beta_1 x_1 + \beta_2 x_1^2$ then the first derivative of the right hand side gives $\beta_1 + 2\beta_2 x_1 = 0$ or that $x_1 = |\beta_1 / -2\beta_2|$. Therefore, for the PMOS ratio turnaround, 0.626/-2(-0.535) = 0.585, and for the FMF ratio, 0.623/-2(-0.575) = 0.542. Note: When using Probit, partial effects are used vice beta coefficients.

assume that an officer had a PMOS ratio of 0.60. If he had served an additional tour in his PMOS vice in a "B" billet, assuming a two-year tour over 10 years of service, this would increase his PMOS ratio to 0.80. The result of this ratio increase would be a 0.42 percent decrease in the predicted probability of promotion to major, all else equal.[6] Assuming a similar situation, where all other variables remain the same, but an officer had an FMF ratio of 0.80 due to an additional FMF tour, the model predicts a 1.8 percent decrease in the predicted probability.

c. Model (3) – Heckman Corrected PMOS and FMF Ratios

It has already been established that between the attrition associated with promotion to captain, and augmentation, and the later attrition of promotion to major, that officers have a choice of whether to remain in service or resign. In the case of this study, when a promotion model was estimated using only those officers who had stayed to the promotion point, there was a potential for selection bias—there were officers in the sample who could have stayed until the promotion point of major, but they chose to separate from the service at a point prior to the convening of a selection board to major. This selection bias could result in underestimated true effects in model (1) if high ability officers separated due to better civilian opportunities. Vice versa, if low ability officers separated, because they believed they would not be promoted, the estimates of the model would be overestimated.

To correct for possible self-selection bias in model (1) and model (2), the Heckman procedure was used. The first part of this two stage process was to identify variables that would contribute to officers staying or leaving the service, but that would not contribute to the promotion probability. Using these instrumental variables, an estimated dependent variable was created that accounts for these exogenous variables. The second stage Probit used this output from the first stage to incorporate the fact that the probability of separation before the promotion board was less than one. The benefit of this method is that the estimates produced by the second stage equation do not

6 The change in probability is given by $[\beta_1 + 2\beta_2 x_0]\Delta x$. Using the partial effects for PMOS Ratio and PMOS Sq from Table 4, [0.626 – 2(0.535)(0.60)]*0.20 = -0.0032. To find percent change, 0.0032 is divided by the model predicted probability of 0.762, or a 0.42 percent decrease in the predicted probability of promotion.

incorporate the self-selection bias for the observations that could have stayed for the promotion board.

The instrumental variables used for the STAY model, the first stage equation in the Heckman procedure, included commissioning source, demographics, PMOS, and fitness report flags for commendatory and derogatory material. Given that the intent of Marine Corps promotion process is to promote the best and fully qualified officers, then unless the process contains discrimination, the assumption can be made that these variables selected would not explain the probability of promotion—this includes both commendatory and derogatory material given that performance is the most heavily weighted factor, commendation is subjective, and the move away from the zero-defect mentality. However, the way individuals perceive their military service, what effect age and marital status have, and what civilian opportunities may exist, will have a major impact on the stay or leave decision. Results for the STAY model can be found under Appendix A.

The results of the Heckman procedure are presented in Table 5 on the following page. Note that 8881 observations were used in model (3) vice the reduced sample from the previous models. The first indication that there may have been an bias in model (1) and model (2) was that the predicted probability of promotion to major decreased to 0.671 and 0.658 respectively. There does not appear to be major differences in significant variables, coefficients, and partial effects; however, calculations must be made to show the estimated effects with this control for self-selection bias.

Analysis of model (3) was made using the same calculations applied in model (1). The partial effect of the FMF ratio increased to 0.129 in model (3); however, the predicted probability of promotion to major decreased to 0.671. If an officer's FMF ratio increased from 0.40 to 0.60—the effect of being assigned an additional two year FMF tour—then this would be associated with a 3.8 percent increase in the predicted probability, all else equal. This value is slightly higher than the 3.2 percent predicted in model (1).

Table 5. Probit Estimates using the Heckman Procedure

	PROMOTION TO MAJOR (3)		PROMOTION TO MAJOR (4)	
	Heckman Probit coefficients (3)	Partial effects (3)	Heckman Probit coefficients (4)	Partial effects (4)
PMOS RATIO	-0.087 (0.145)	-0.032	1.947 (0.808)**	0.714
PMOS SQ	___	___	-1.669 (0.665)**	-0.612
FMF RATIO	0.357 (0.149)**	0.129	1.936 (0.539)***	0.711
FMF SQ	___	___	-1.802 (0.571)***	-0.662
PI	4.620 (0.269)***	1.671	4.568 (0.269)***	1.677
OCC	-0.085 (0.072)	-0.031	-0.066 (0.073)	-0.024
NROTC	-0.325 (0.064)***	-0.121	-0.329 (0.064)***	-0.124
USNA	-0.392 (0.084)***	-0.149	-0.393 (0.085)***	-0.151
ECOMM	-0.538 (0.082)***	-0.207	-0.509 (0.082)***	-0.197
TBSPERC	0.149 (0.095)	0.054	0.125 (0.095)	0.046
MARRIED	-0.056 (0.055)	-0.020	-0.052 (0.055)	-0.019
BLACK	0.032 (0.100)	0.012	0.029 (0.100)	0.011
HISPANIC	0.226 (0.157)	0.077	0.229 (0.158)	0.080
OTHER RACE	-0.113 (0.150)	-0.042	-0.124 (0.151)	-0.047
FY CONTROLS	Yes		Yes	
Constant	-25.834 (1.559)***		-26.393 (1.577)***	
Observations	8881		8881	
Cens. Obs.	5190			
$P(\hat{Y} = 1)$		0.671		0.658
ρ	-0.233 (0.078)			-0.222 (0.078)
LR test of indep. eqns. ($\rho = 0$):	$\chi^2 = 8.17$ p-value = .0042		$\chi^2 = 7.42$ p-value = .0065	
log likelihood	-6570.627		-6561.333	

(Source: Author)
Note: Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

The other significant factors seen in the model (3) were the performance index (PI) and the commissioning source. In this model, the partial effect of the PI increased to 1.671. This increase, coupled with the reduced overall predicted probability of promotion to major, predicts a 24.9 percent increase in the promotion probability. The

commissioning sources did not show much of a change from model (1), except for the enlisted commissioning (ECOMM) programs. In model (3) given all else is the same, if an officer were commissioned through an ECOMM, then this corrected model predicts a decrease in the probability of promotion to major by 0.207. This makes sense considering many prior enlisted officers may have reached retirement eligibility prior to the convening of the applicable major's selection board—these officers would have self selected out of the sample used for model (1).

d. Model (4) – Heckman Corrected PMOS and FMF Ratios with Squares

Like model (2) compared to model (1), the difference between model (3) and model (4) was the addition of squared terms for the PMOS and FMF ratios. The calculations made for model (2) were the turnaround points for these ratios as well as the potential decreases in predicted probability of promotion. Using the same method as explained previously, the PMOS ratio turnaround point for the corrected model was calculated at 0.583. The FMF ratio turnaround was calculated at 0.537. These values are slightly less than those predicted in model (2).

To find the percent change in the predicted promotion probability, assume again an officer with all else equal other than an increase in the PMOS ratio to 0.80 from 0.60. The result of this increase, caused by an additional PMOS tour, would be a 0.62 percent decrease in the predicted probability. Likewise, a change from 0.60 to 0.80 in the FMF ratio would be associated with a 2.5 percent decrease in the predicted probability all other factors remaining equal.

4. Conclusions

This section provided a first look out how assignment factors could influence promotion rates. Four models were run to find basic assignment effects, to find out how quadratics could change the results, and after correcting for self-selection bias, how the results could differ given that those officers who fell out of the sample prior to the point of a major's selection board were tested in the model.

Results for these models were similar to other promotion studies by Wielsma, and Ergun. These similarities included the major importance of the performance indicator on

promotion, the significance of commissioning source predicting higher promotion probability for PLC officers over USNA, NROTC, and ECOMM, and the significant but small practical value of TBS class percentile.

The assignment factors studied did show significant results. From the sample studied, it was evident that there was a negative effect on promotion given a high level of either the PMOS ratio or the FMF ratio. In general the model predicts that officers with ratios above 60 percent for both categories would have a reduced probability of promotion. After correction for self-selection bias, the highest practical significance was a 2.5 percent decrease in promotion probability for an officer with an FMF ratio higher than 60 percent.

D. SURVIVAL ANALYSIS

The previous section provided insight into the influence of assignment variables and control factors on promotion to major. As discussed in the introduction, promotion selection is a method of shaping the Marine Corps forces to meet mission requirements. In short, through the promotion selection process, it is the Marine Corps that decides to keep an officer in service or not. This section will use similar assignment and control factors as the previous promotion models, but the purpose will be to discern how these same characteristics contribute to an officer's decision to stay or leave the service prior to the promotion point of major.

1. Model Development

There is not much evidence of survival analysis in the Marine Corps to study manpower issues such as attrition in the Marine Corps. There was a disadvantage in not being able to use a surplus of studies as a baseline for model specification or for comparing results. However, Hoglin conducted a detailed study using a Cox proportional-hazard model, and the technique has also proved useful in many outside studies.

As was noted in the literature review of this study, many common threads were consistent throughout these studies with the differences being the introduction of new factors by the researchers to analyze particular areas of interest. Many of the same

variables have been used to explain both promotion and retention. In this study, assignment variables were added as another factor to explain attrition decisions. Following these guidelines, an attrition model can be expressed as follows:

attrition = *f*(assignment variables, commissioning source, personal characteristics, and career characteristics)

To limit the amount of bias that would be caused by leaving out unaccounted for year-specific factors, dummy variables were introduced for the fiscal year at commissioning for each observation. Each cohort spanned a different 10 to 11 year period. If there was a measurable difference between the periods, these cohort dummy variables would act as controls for the differences.

2. Hypothesized Effects

Beginning with assignments, the distinction between the Fricker study and the other studies was the introduction of a personnel tempo variable. Although service in an operational billet does not necessarily equate to time deployed, it is within these operational billets that operational tempo increases—extended exercises are conducted in training areas away from the family and duty station, and also many Marines deploy to sea and are assigned unaccompanied tours overseas while assigned in the FMF. As noted by Fricker, increased attrition would be expected if the ratio of FMF days to overall days became too high.

Referring to the occupation itself, Marine officers not only alternate between FMF and non-FMF tours, but they also rotate from primary occupation billets to non-primary billets. Officers may become drained if they perform the same tasks repetitively. Therefore, spending some time outside the PMOS may show a decrease in attrition. On the other hand, as time outside the PMOS increases, attrition may increase.

The other assignment flags will most likely produce mixed results. As this may be based more on the individual taste of the officer, it is difficult to predict how serving in these billets could affect attrition. Assuming that officers chose to serve in the military as part of a need to fill personal desires for action, adventure, and patriotism, serving in combat and security force billets would most likely be associated with decreased attrition, while serving in recruiting may have the opposite effect.

Studies by both Hoglin and Ergun found that OCC and PLC officers are more likely to attrite than those commissioned through USNA. Results for commissioning through NROTC and enlisted commissioning programs were mixed. For the demographics, previous studies have shown reduced attrition for minority races compared to white officers. Additionally, married officers showed reduced attrition.

How serving in a particular PMOS group affects attrition is based on individual taste and whether the officer was able to serve in a desired occupation or not. However, as with assignments, it could be assumed that combat MOSs will have lower attrition than the other occupations. On the other hand, Hoglin found that combat MOS officers had a greater hazard of attrition.

Finally, class standing at TBS and the fiscal year cohort effects are used as other control variables. Most other studies have shown that being ranked in the top third of the TBS class predicted reduced attrition, while being ranked in the bottom third predicted an increase in attrition. As discussed before, the fiscal year cohort variables control for year-specific biases that would affect everyone in those years the same way. These effects would include possible decreases in attrition during the Gulf War, increases in attrition during the force drawdown of the early 1990s, followed by possible decreases in attrition during actions in Somalia, Bosnia, and Kosovo, as well as possible decreases in attrition due to the economy slump in the late 1990s.

3. Preliminary Findings

To provide a base from which to explore other directions, an attempt to replicate Hoglin's methodology was made. As stated before, Cox proportional-hazard analysis can allow for a censoring point. To get the maximum amount of observations, Hoglin used September 2000 as his censoring point for all cohorts of officers who had been accessed in the Marine Corps from 1986 to 2000. Therefore, his results include officers who had been in service up to 14 years as well as those who had only been in service for approximately one year. This is a perfectly acceptable method to use, yet it does not meet the intent of this study.

The right censoring point of this study was at 10 years of commissioned service. Each officer cohort who had been accessed from 1980 to 1989 was followed up to the 10-

year mark to analyze the overall effect of the descriptive variables on survival up to the point just prior to promotion to major. In this way, all observations in the sample had the potential of serving at least 10 years. This point was chosen in reference to Figure 2 and Figure 3 as a point just prior to the potential for forced attrition due to failure for selection to major. Table 6 below shows some similarities and differences between Hoglin's results and the results from this study, in which this different methodology was used.

For a few reasons, even censoring the model at the 10-year mark did not meet the intent of this study. The main problem can be seen in Figure 2 in the previous chapter. For the first three years there was essentially no attrition, which is explained by initial contracts signed by officers at accession. This point is followed by steep attrition due to the expiration of contracts. Furthermore, between the four and five year mark, officers were up for promotion to captain and had to compete for augmentation (contracts for USNA and full scholarship NROTC graduates also expired at the five year mark).

If officers continued service beyond the five mark, they surpassed a point of forced attrition. These officers displayed a taste for the military lifestyle. Attrition beyond this point, and up until the 10-year mark as discussed above, was based on their own decision rather than that of a Marine Corps process. Therefore, by estimating an additional model, which included a left censoring point—five years of commissioned service, only officers who made their own choice to serve or attrite were analyzed. It is here that the intent of this study has been met, and further analyses can be conducted for comparison purposes.

The most obvious differences between Hoglin's results and the results of this analysis were found in the commissioning sources. When a methodology similar to Hoglin's was used, as noted in the second column of results above, nearly all of the results were the same. However, when the sample was changed to include only those officers whose decision to continue to serve or attrite was their choice, distinctly different results were evident. In fact, some variables showed sign changes and also others had hazards for attrition which were significantly reduced. Since the base case was an officer who had a USNA regular commission, one explanation for the difference is that Hoglin's

model did not account for the later attrition of USNA officers, due to an extended contract length, over the other commissioning sources with a shorter contract length.

Table 6. Comparison of Different Survival Methodologies

	Hoglin's Survival Model Results (Grade independent)	**Survival Results using Hoglin's Methodology (2ndLt to Major)**	**Survival Results Left and Right Censoring (Captain to Major)**
	Censoring of observations at September 2000	Censoring of observations at 10 years commissioned service	Censoring of observations from 5 years to 10 years commissioned service
Variable	**Hazard Ratio**	**Hazard Ratio**	**Hazard Ratio**
Prior Enlisted	0.938*	1.094+	0.885
Commissioning Source			
PLC	1.329***	1.349***	0.578***
OCC	1.734***	1.719***	0.591***
NROTC	1.199***	1.000	0.584***
MECEP	0.720***	n/a	n/a
ECP	1.746***	n/a	n/a
MCP	0.758	n/a	n/a
ECOMM	n/a	0.867	0.316***
Personal Characteristics			
Female	0.905	n/a	n/a
COMM_AGE	0.966***	0.927***	0.935***
Married	0.412***	0.554***	0.708***
Black	0.928	1.060	1.059
Hispanic	0.958	1.026	0.987
Other Race	0.949	0.929	0.982
Career Characteristics			
Top TBS Third	0.86***	0.803***	0.843***
Bottom TBS Third	1.244***	1.319***	1.279***
GCT_CAT	1.032	1.026	1.047
MOS_COMBAT	1.757***	0.877***	0.903+
MOS_SERVICE	2.004***	0.885+	0.913
MOS_GRNDSUPT	n/a	0.882***	0.884*
Fiscal Year Control	Yes	Yes	Yes
n	14935	8517	5741
-2 Log L	103204.25	42424.25	19515.52
Likelihood Ratio	2250.78	1384.39	586.52

(Source: Hoglin—column 1; Author—columns 2 and 3)
* significant at 10%; ** significant at 5%; *** significant at 1%; + marginally significant

An additional difference can be seen in the MOS group categories. Hoglin's base case was defined as combat support. These officers included all of the pilots and NFOs that had greater contract lengths—six to eight years—than the ground officers. Thus, his

results clearly made sense that the other MOS groups would have a much higher hazard for attrition. The results for MOS groups used in this study cannot be readily compared to Hoglin's. Quite a few differences exist as pilots and NFOs were removed from the sample, and where Hoglin used O'Brien's MOS group assignments, this study used Wielsma's group assignments.

4. Model Analysis and Results

Four different models were constructed to test the effects of assignments on the survival of officers between five and 10 years of service. The main variables of interest were the effects of the PMOS ratio, the FMF ratio, and other assignment flags. Due to its reported importance in previous studies, a performance indicator was added to these models. The base case for all models unless otherwise noted was an officer who was single, white, a PLC graduate, in a Combat PMOS, who had graduated from TBS in the middle third, and had no prior enlisted service.

a. Model (1) -- PMOS and FMF Ratios

Table 7 shows the results of running the Cox proportional-hazard regression for model (1)—PMOS and FMF Ratios. The initial model setup from Table 6 was used, with the introduction of the assignment variables PMOS ratio and FMF ratio. Interpretations for the binomial variables are easier than interpretations for the continuous variables—the PMOS ratio, the FMF ratio, the performance indicator, and the commissioning age. The hazard ratios for the dummy variables are compared to the base case as a greater or lesser hazard for attrition. Interpretations of the continuous variables are based on a unit increase in the explanatory variable; i.e., by subtracting '1' from the hazard ratio and multiplying by 100, the result is the percent change in the hazard for a '1' unit increase in the explanatory variable.

The results under model (1) indicate that the assignment ratios, the USNA commissioning source, the Air Support MOS group, TBS ranking, commissioning age, and marital status were all statistically significant. Recall that the range of values for the PMOS and FMF ratio are from '0' to '1.' Thus, a more practical change in the value of the explanatory variable would be an increase of 0.20—this unit change was used under the promotion model section of this study to describe an officer who had been assigned an

additional two-year tour in his PMOS or in the FMF over the 10 year period studied. By subtracting '1' from the hazard ratio of the PMOS ratio, and multiplying 100, then multiplying by the 0.20 unit increase, the percent change in hazard is equal to 11.7 percent decrease in the hazard of attrition, all other factors equal.

Table 7. Cox Hazard Results Testing for Assignment Ratios

	Model (1)	Hazard Ratio from (1)	Model (2)	Hazard Ratio from (2)
PMOS RATIO	-0.8811 (0.1278)***	0.414	-0.6519 (0.1268)***	0.521
FMF RATIO	-0.0682 (0.1373)***	0.505	-0.3781 (0.1337)***	0.685
PI	——	——	-2.3619 (0.0857)***	0.094
OCC	0.0392 (0.0723)	1.04	0.1299 (0.0723)*	1.139
USNA	0.5714 (0.0586)***	1.771	0.6018 (0.0612)***	1.825
NROTC	0.0617 (0.0586)	1.064	0.0965 (0.0590)*	1.101
ECOMM	-0.5478 (0.1336)	0.578	-0.4287 (0.1346)***	0.651
MOS_GRNDSUPT	0.0241 (0.0486)	1.024	0.0417 (0.0487)	1.043
MOS_SERVICE	-0.0029 (0.1116)	0.997	0.0408 (0.1114)	1.042
MOS_AIRSUPT	0.2018 (0.0703)***	1.224	0.2173 (0.0706)***	1.243
TBS Top_Third	-0.1406 (0.0552)***	0.869	-0.0366 (0.0554)	0.964
TBS Bot_Third	0.2270 (0.0522)***	1.255	0.0394 (0.0529)	1.04
PRENL	-0.1498 (0.1142)	0.861	-0.1179 (0.1153)	0.889
COMM_AGE	-0.0676 (0.0159)***	0.935	-0.0834 (0.0159)***	0.92
MARRIED	-0.3426 (0.0436)***	0.71	-0.2439 (0.0441)***	0.784
BLACK	0.0407 (0.0857)	1.042	-0.1135 (0.0863)	0.893
HISPANIC	-0.0230 (0.1294)	0.977	-0.0318 (0.1294)	0.969
OTHER RACE	-0.0729 (0.1308)	0.93	-0.1579 (0.1311)	0.854
FY CONTROLS	Yes	Yes	Yes	Yes
Observations	5981		5981	
Censored Obs.	3798		3798	
-2 Log L	20180.875		20180.875	
Likelihood Ratio	719.556		1202.865	

(Source: Author)
Note: Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

The same percent change can be calculated for the FMF ratio. Again using the 0.20 standard, the percent change in hazard for the FMF ratio is equal to a 9.9 percent decrease for the hazard of attrition, all else equal. Both the PMOS ratio and the FMF ratio provide a linear percent change for any level of ratio, which may not be accurate. The last model in this section, model 4, will present a possible solution. Nonetheless, certainly at the lower ratio levels, it makes sense that as the ratios increase, the hazard for attrition decreases. The main reasons for this could be satisfaction in the PMOS—the ability to do the job trained to do—and more satisfaction with FMF duty assignments—preferring the FMF as Marine fighting units vice unattractive work in alternate assignments.

Although Hoglin found that officers with OCC and PLC commissioning sources had a greater hazard for attrition than USNA graduates, the results under model (1) in Table 7 show that USNA had a hazard rate of 177 percent of PLC graduates—nearly the opposite. Two explanations for this difference were discussed before. First, looking back at Figure 2, steep attrition began at the three year mark; however, USNA graduates had five years of obligated service at that time. Second, this problem would be magnified by the sample in Hoglin's study which included all officers up to just one year from commissioning—for at least one quarter of the sample, from 1995 to 2000, would have practically no attrition for USNA graduates.

Moving on to the Air Support MOS, the results indicate that this group has hazard rate 122 percent of combat MOSs. This may be explained partially by looking at Figure 3, which shows that the Air Support MOS group had higher attrition over the years. On the other hand, the percent drop between the combat MOSs and the air MOSs looks similar. Other possible explanations would only be guesswork; i.e., it could be anything from stress on the job (air traffic control is part of this group), to the outside civilian market for officers in this field.

Interestingly, much closer results were found between this study and Hoglin's in the areas of TBS ranking, marital status, and commissioning age. The TBS ranking category was nearly the same as Hoglin's with the top third showing a hazard of 86.9 percent of the middle third, and the bottom third showing a 125.5 percent hazard

(compared to Hoglin's 86 and 124 percent hazard ratios). Marital status was somewhat different with this study showing married officers with a 71 percent hazard of that of single officers. Hoglin's study showed a lower hazard of 42 percent. A possible explanation can again be found in the sample, with a greater percentage of single officers attriting in Hoglin's sample as followed his observations from second lieutenant to attrition, while this study followed officers from captain to attrition. Finally, commissioning age was also similar with a hazard ratio of 0.935 compared to Hoglin's finding of 0.966. For this study, the hazard ratio is interpreted by 100(0.935 - 1) percent, or a 6.5 percent decrease in the hazard for each year of commissioning age.

b. Model (2) – PMOS and FMF Ratios with Performance Control

The difference between Model (2) and Model (1) is the addition of the performance indicator. By controlling for the effect of performance, the hazard ratios for the PMOS and FMF ratios increase in magnitude, which actually equates to a smaller hazard per unit of increase of the explanatory variable. Additionally, commissioning sources become more significant while the TBS thirds become insignificant, and the effects of marital status and commissioning age stay about the same.

The performance indicator was significant in model (2) as can be seen in Table 7. The effect of this variable was found using the same equation used for the other continuous variables: 100(0.094 – 1)(0.1)—multiplied by 0.1 to indicate the percent hazard for a 0.1 unit change in the performance indicator. This equated to a 9.06 percent decrease in the hazard of attrition over officers with PIs 0.10 less; e.g., an officer with a PI of 5.9 has a hazard that is 9.06 percent less than the hazard of an officer with a PI of 5.8. What this also indicates is the possibility that hazard ratios in model (1) may be overstated.

With performance as a control, the hazard of attrition for the PMOS ratio dropped to 9.6 percent when using a 0.20 increase in the ratio. Thus, an officer with a 0.60 PMOS ratio has a hazard 9.6 percent less than the hazard for an officer with a 0.40 PMOS ratio. The hazard for the FMF ratio dropped to 6.3 percent when using the 0.20 increase in the ratio. In model (2), with retention that was due to high performance, or attrition that was due to low performance now controlled for, the resulting hazard ratios for the other explanatory variables will be more accurate.

The biggest changes were in the commissioning sources when controlling for performance. The results show that officers from an enlisted commissioning source had the lowest attrition hazard—65.1 percent of the PLC officers. This can be explained by these officers having higher acculturation, and also being closer to retirement, both resulting in lower attrition. The other results are somewhat similar to Hoglin's with the main difference being USNA. NROTC also has a reduced hazard for attrition which could be partly explained by a portion of those officers also having had mandatory five year contracts.

The other big change was the TBS class ranking categories becoming insignificant. From an attrition standpoint, this would say that once an officer has reached the grade of captain, it is not the TBS ranking that matters, but the performance. An assumption would be that officers who may not have preferred their PMOS assignment would most likely have gotten out prior to selection to captain. What would be left in the sample are officers who had gotten one of their top choices. If they were performing well, then this model shows that TBS ranking no longer has explanatory power for attrition.

c. Model (3) – PMOS and FMF Ratios with Assignment Flags

Model (3) keeps the same specification as Model (2), however, the addition of assignment flags have been made—results are shown under Table 8. These assignment flags show the effect on survival of having served in a joint tour, in combat, in recruiting, in Marine Security Guard or Security Forces, or tours on the Drill field. The results of this model show that all assignment flags are significant when the PMOS and FMF ratios, as well as the performance indicator, are used as controls. These results support the hypothesis that diversity in an officer's career lowers the hazard of attrition.

Comparing the results of model (3) to the other models does not show much of a difference in the majority of the significant variables. When controlling for other assignment factors, the hazard for officers with a PMOS ratio 0.20 greater than another officer, all else equal, is decreased by 10.8 percent. Additionally, the hazard of attrition of an officer with a 0.20 greater FMF ratio is 5.5 percent less.

Table 8. Testing for Assignment Flags

	Model (3)	Hazard Ratio from (3)
PMOS RATIO	-0.7770 (0.1288)***	0.46
FMF RATIO	-0.3211 (0.1327)***	0.725
JOINT	-0.6892 (0.0967)***	0.502
COMBAT	-0.2828 (0.0497)***	0.754
RSOST	-0.2890 (0.0735)***	0.749
MSGMCSF	-0.4978 (0.0778)***	0.608
DRILL	-0.3755 (0.0713)***	0.687
PI	-2.1742 (0.0875)***	0.114
OCC	0.1203 (0.0722)*	1.128
USNA	0.6066 (0.0615)***	1.834
NROTC	0.1492 (0.0594)***	1.161
ECOMM	-0.4434 (0.1350)***	0.642
MOS_GRNDSUPT	-0.0239 (0.0494)	0.976
MOS_SERVICE	-0.0334 (0.1121)	0.967
MOS_AIRSUPT	0.0644 (0.0721)	1.067
TBS Top_Third	-0.0450 (0.0554)	0.956
TBS Bot_Third	0.0221 (0.0529)	1.022
PRENL	-0.0900 (0.1157)	0.914
COMM_AGE	-0.0830 (0.0158)***	0.92
MARRIED	-0.2645 (0.0442)***	0.768
BLACK	-0.1129 (0.0864)	0.893
HISPANIC	0.0304 (0.1295)	1.031
OTHER RACE	-0.1139 (0.1310)	0.892
FY CONTROLS	Yes	Yes
Observations	5981	
Censored Obs.	3798	
-2 Log L	20180.875	
Likelihood Ratio	1362.130	

(Source: Author)
Note: Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

The other assignment factors also show interesting results in Table 8. Of all the assignment factors, all else equal, the greatest effect is for an officer who has served in a joint tour. The hazard for attrition is 50.2 percent of an officer who has not served in a joint billet. The following variable is for an officer having served in a Marine Security Guard or Marine Corps Security Forces unit, which equates to 60.8 percent attrition of an officer who has not served in one of those duties. Drill field duty results in a hazard of 68.7 percent, while combat and recruiting tours come in about the same at 75 percent of the hazard.

Many of the billets assigned on these duties disclosed above are outside of the officer's PMOS. Thus the assumption can be made that these tours are providing something to the officer that keeps them separating. In combat, the effect may be attributed to being able to use training received in a real world situation. This may also be the case of Security Guard and Forces duty. In addition, joint, recruiting, and drill field duty certainly provide diversity.

d. Model (4) – PMOS and FMF Ratios as Discrete Values

In the promotion model, a quadratic term was used to show the turnaround point of the FMF and PMOS ratios that resulted in a lower probability of promotion on the high end of the scale. There was some difficulty in using quadratics in the Cox hazard regression. Accurate results could not be calculated. However, there is another method to show what kind of effect different levels of these ratios would have on attrition. To test this concept without having to use quadratics, dummy variables were calculated for discrete values of the PMOS and FMF ratios in increments of 15 percent (the last value was 10 percent). The results of model (4) can be found under Table 9.

Similar to the other models, the descriptive variables other than the PMOS and FMF ratios did not change much with this new model. However, what was evident was the wide array of hazard ratio values for the assignment ratios. Since these were coded as discrete dummy variables, the interpretation is more straight forward.

Looking first at the PMOS ratio, the two variables that were significant included the officers whose ratios fell between zero and 15 percent, and 31 to 45 percent. This last method provides some interesting results—if an officer's PMOS ratio is between

zero and 15 percent, the hazard for attrition is 147 percent of an officer whose ratio is between 46 and 60 percent. Likewise, and officer whose PMOS ratio is between 31 and 45 percent has a hazard that is 125 percent of an officer with a ratio between 46 and 60 percent. This reveals more information about the PMOS ratio, as the previous models gave the impression that the percent change in the hazard, based off of the PMOS ratio, was linear and negative – each additional unit of PMOS ratio caused a decrease in the hazard. From the information provided in model (4), this is not the case.

Table 9. Testing for Discrete PMOS and FMF Ratios

	Model (4)	Hazard Ratio from (4)
PMOS RATIO 1 0% to 15%	0.3886 (0.1660)**	1.475
PMOS RATIO 2 16% to 30%	0.1259 (0.0860)	1.134
PMOS RATIO 3 31% to 45%	0.2204 (0.0620)***	1.247
PMOS RATIO 5 61% to 75%	-0.0725 (0.0615)	0.93
PMOS RATIO 6 76% to 90%	-0.0943 (0.0654)	0.91
PMOS RATIO 7 91% to 100%	-0.2386 (0.1570)	0.788
FMF RATIO 1 0% to 15%	0.4803 (0.0964)***	1.617
FMF RATIO 2 16% to 30%	0.6037 (0.0604)***	1.829
FMF RATIO 3 31% to 45%	0.4867 (0.0573)***	1.627
FMF RATIO 5 61% to 75%	0.2472 (0.0802)***	1.28
FMF RATIO 6 76% to 90%	0.9503 (0.0875)***	2.587
FMF RATIO 7 91% to 100%	0.1313 (0.2565)	1.14
JOINT	-0.7007 (0.0969)***	0.496
COMBAT	-0.2909 (0.0497)***	0.748
RSOST	-0.2014 (0.0745)***	0.818
MSGMCSF	-0.4226 (0.0782)***	0.655
DRILL	-0.2678 (0.0723)***	0.765
PI	-2.0656 (0.0905)***	0.127
OCC	0.1000 (0.0723)	1.105
USNA	0.6171 (0.0617)***	1.854
NROTC	0.1569 (0.0594)***	1.17

ECOMM	-0.4813 (0.1356)***	0.618
MOS_GRNDSUPT	-0.0713 (0.0498)	0.931
MOS_SERVICE	-0.0642 (0.1125)	0.938
MOS_AIRSUPT	0.0375 (0.0727)	1.038
TBS Top_Third	-0.0213 (0.0557)	0.979
TBS Bot_Third	0.0295 (0.0531)	1.03
PRENL	-0.0623 (0.1165)	0.94
COMM_AGE	-0.0828 (0.0158)***	0.921
MARRIED	-0.2546 (0.0441)***	0.775
BLACK	-0.1148 (0.0866)	0.892
HISPANIC	0.0240 (0.1297)	1.024
OTHER RACE	-0.1032 (0.1312)	0.902
FY CONTROLS	Yes	Yes
Observations	5981	
Censored Obs.	3798	
-2 Log L	20180.875	
Likelihood Ratio	1544.286	

(Source: Author)
Note: Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

The results for the FMF ratio are even more interesting. Taken as a whole, as discussed above with the PMOS ratio, the previous models showed that the FMF ratio was linear and negative – each additional unit of FMF ratio caused a decrease in the hazard (other than a slight jump at the 16 to 30 percent range). However, model (4) shows that although there is a general trend which shows a decrease in the hazard, all of the discrete variables are significant and greater than '1,' except for an FMF ratio from 91 to 100 percent. It could be inferred from this model that the most successful FMF ratio range for retention is within 46 to 60 percent. It is also clear that when the FMF ratio is between 76 and 90 percent that the hazard of attrition becomes quite large at 259 percent of those officers with FMF ratios between 46 and 60 percent. This finding supports Fricker's finding that increased operation tempo has caused greater attrition of mid-grade Marine Corps officers.

5. Conclusions

This section on survival analysis provided an additional look out how assignment factors could influence officer careers. Four models were run to discover what kind of effect assignments had on survival and attrition of mid-grade officers. Areas tested included a comparison using the effect of performance, the effect of other specific assignment flags, and an investigation of discrete values for the PMOS and FMF ratios to provide more detail to the effect of those variables.

Results for these models were at times similar to the attrition study by Hoglin. The most common ground was found in marital status, commissioning age, and TBS class standing. Major differences were evident in the area of commissioning sources. Curiously, Hoglin did not use a performance indicator (PI); however, as the TBS thirds were insignificant when the PI was introduced in this study, there is most likely some correlation between the two variables.

The assignment factors studied did show significant results. The models predicted that as the PMOS and FMF ratios increased there was an decrease in the hazard of attrition; however, the discrete values for the FMF ratio, in the fourth model, predicted a turnaround point at the 46 to 60 percent range—the hazard for attrition decreased up to this point but increased at the 61 to 75 percent and 76 to 90 percent levels. This finding validated Fricker's study, which found that high operational tempo can cause increased attrition. Although the variable used in this study was different, high operational tempo is indicative of tours spent in the FMF. Regarding the other assignment flags, officers who had served in these combat and alternative tours outside the PMOS showed a decrease in the hazard of attrition.

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V. CONCLUSIONS AND RECOMMENDATIONS

Great things do not just happened by impulse, but are a succession of small things linked together.

—Vincent Van Gogh

This is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning.

—Winston Churchill

A. CONCLUSIONS

Many past studies have been conducted in the areas of promotion, attrition, and retention, and these will continue far into the future. Conflicting results are often caused by the data available, the methodology used, or simply the changing times. Conversely, much of what has been studied in these areas appears timeless, as study after study concludes with similar results. This study was a little of both.

The intention of this research was to pull on the loose thread of the topic of assignments and discover where it led. How assignments relate to promotion and retention was unclear. Assignments had been used as static variables based on the last duty station, and also as the related variable operational time, but not to describe officers' career paths. Beginning with previously used promotion and attrition models, a method was designed to add assignment variables to these tested models.

The primary purpose of this study was to examine how the ratios of primary occupation time over total time served and Fleet Marine Force time over total time served affected the probability of promotion and the hazard of attrition for USMC mid-grade officers. Secondary to the effect of assignments overall, questions included an examination of any particular effects found in certain PMOS groups, and if any other factors studied had a significant impact on promotion or attrition.

The final data set used consisted of 8956 commissioned officers who were commissioned from fiscal years 1980 to 1989, had begun their careers as second

lieutenants, and progressed normally through the promotion system. Females, pilots, NFOs, and lawyers were removed from the sample.

Of the original sample, 2713 officers were promoted to major; however, only 3698 remained in service long enough to be seen by the major's promotion board. This selection rate of 73.36 percent was just a little over one percent of the average promotion rate during the time this sample of officers was in zone from promotion. Additionally, 5254 officers did not stay in service long enough to be seen by the major's promotion board. Of these officers, 2051 stayed in service beyond the five year mark—beyond the forced attrition of promotion and augmentation. The average attrition time for these officers was just slightly over the seven year mark, with a standard deviation of 18 months.

The average ratios of FMF and PMOS days to career days from second lieutenant through captain were 46.7 percent and 58.7 percent respectively. Additionally, about 30 percent of the officers had combat fitness reports, and from seven to 10 percent had billets on joint tours, on the drill field, in recruiting, and in Marine Security Guard or Marine Corps Security Forces billets.

Four models were run to find how assignment affected promotion to major. The first model was based on previous studies, with the addition of the PMOS and FMF ratios. The second model had the addition of quadratic forms of the PMOS and FMF ratios to see if the effects of these variables were curvilinear. The third and fourth models used the first and second model specifications, but these were corrected for self-selection bias.

Results for these models were similar to past promotion studies. These similarities included the major importance of the performance indicator on promotion, the significance of commissioning source predicting higher promotion probability for PLC officers over USNA, NROTC, and ECOMM, and the significant but small practical value of TBS class percentile.

The assignment factors also showed significant results. There was a negative effect on promotion given a high level of either the PMOS ratio or the FMF ratio. The model predicted that officers with ratios above 60 percent for both categories would have

a reduced probability of promotion. After correcting for self-selection bias, officers with a PMOS ratio greater than 60 percent had a 0.62 percent decrease in predicted promotion probability. The FMF ratio had a higher practical significance, predicting a 2.5 percent decrease in promotion probability for officers with FMF ratios higher than 60 percent.

The section on survival and attrition analysis provided an additional look out how assignment factors could influence officer careers. Four models were run to discover what kind of effect assignments had on survival and attrition of mid-grade officers. The first and second model used variables similar to the promotion models. The third model was a study specifically in the area of other assignment factors. The fourth model changed the PMOS and FMF ratios into discrete values for further analysis.

Results for these models had mixed results compared to previous attrition models. Common ground was noticed in marital status, commissioning age, and TBS class standing. Major differences were evident in the area of commissioning sources. These differences were most likely due to different samples and methodology. Factors such as mandatory contract lengths and reducing the sample to just those officers who were in service past the five year mark were the most likely candidates.

The assignment factors studied did show significant results. From the sample studied, it was evident that the PMOS ratio, the FMF ratio, and the other assignment flags—joint, combat, security forces, recruiting, and drill—did play a role in attrition and retention decisions.

Generally speaking, the models predicted that as the PMOS and FMF ratios increased there was an decrease in the hazard of attrition; however, the discrete values for the FMF ratio, in the fourth model, predicted a turnaround point at the 46 to 60 percent range—the hazard for attrition decreased up to this point but increased at the 61 to 75 percent and 76 to 90 percent levels. This finding validated other studies that have shown that high operational tempo causes increased attrition—this being equated to an FMF ratio above 61 percent. Regarding the other assignment flags, officers who had served in these combat and alternative tours outside the PMOS showed a decrease in the hazard of attrition.

Table 10 below provides a summary of findings from both the promotion and attrition studies. The majority of the hypothesized effects were validated. However, there were some insignificant results and results that had an opposite effect than that expected.

Table 10. Promotion and Attrition Comparative Results

Variable	Hypothesized Effect (promotion)	Observed Effect (promotion)	Hypothesized Effect (stay)	Observed Effect (stay)
Assignment				
Ratio of FMF days	+	+	+	+
Square of FMFRatio	–	–	–	–
Ratio of PMOS days	+	+	+	+
Square of PMOSRatio	–	–	–	–
Combat fitness report	n/a	n/a	+	+
Joint fitness report	n/a	n/a	?	+
Security billet	n/a	n/a	+	+
Drill field billet	n/a	n/a	?	+
Recruiting billet	n/a	n/a	–	+
Performance				
Performance Index	+	+	+	+
TBS class ranking (%)	+	n.s.	n/a	n/a
TBS Top Third	n/a	n/a	+	n.s.
TBS Middle Third	n/a	n/a	Base	Base
TBS Bottom Third	n/a	n/a	–	n.s.
Occupation				
MOS_Combat	n/a	n/a	Base	Base
MOS_GrndSupt	n/a	n/a	–	n.s.
MOS_AirSupt	n/a	n/a	–	–
MOS_Service	n/a	n/a	–	n.s.
Commissioning				
PLC	Base	Base	Base	Base
OCC	+	n.s.	–	–
NROTC	–	–	+	–
USNA	–	–	+	–
ECOMM	–	–	+	+
Demographics				
Age at commissioning	n/a	n/a	+	+
Prior Enlisted Service	n/a	n/a	–	n.s.
Married	+	n.s.	+	+
White	Base	Base	Base	Base
Black	–	n.s.	?	n.s.
Hispanic	–	n.s.	?	n.s.
Other Race	+	n.s.	?	n.s.

(Source: Author)
Note: Results found statistically insignificant noted by "n.s."

Insignificant results included TBS class ranking, some MOS groups, prior enlisted service, and ethnic race. This was interesting, as TBS class ranking has been used in many promotion and attrition models in the past. There was no clear reason for the insignificance; however, it may be that once an officer has made it past promotion to captain, there is little explanatory power left in TBS class standing. It could be assumed that at this point in an officer's career it is performance that really matters.

Likewise, MOS occupations and ethnicity did not play a significant role in either promotion or attrition; however, air support MOSs did show a significant increase in the hazard of attrition over combat MOSs. The reason was also not clear. An assumption could be that stress on the job (air traffic control is part of this group) or better civilian opportunities had something to do with the greater attrition.

The last two areas of statistical insignificance were in ethnicity and prior enlisted service. Assuming there was no discrimination in the promotion process, the insignificance of ethnicity makes sense. Additionally, prior enlisted service could have indicated enough service to retire from the service. The insignificance may have been caused due to all levels of enlisted service being contained in one variable—no distinction was made between a prior lance corporal and a prior sergeant.

The results contradicted the hypothesized effects for commissioning source and for service in recruiting. Commissioning source has been used frequently in previous studies and the hypothesized effect was based on those studies. It was deduced that the change in sign was caused by different sample parameters and different methodologies used in the analysis. It would be reasonable to believe that the main reason behind the change was due to longer mandatory contract lengths in USNA and NROTC graduates that had biased previous results. The recruiting hypothesis was based on conjecture, as this variable was not included in previous studies. The rationale was that many negative stories are heard about recruiting. The results of this study predict a different effect.

In final conclusion, there is strong evidence that assignments over officers' careers affected both the probability of promotion and the decision on whether to continue to serve at the mid-grade level in the Marine Corps. Looking back over Chapter IV, and comparing both studies, it is encouraging to note that there were no major differences in

the ways that the variables affected the outcomes. There was no evidence that the Marine Corps promotion process favored certain characteristics which were also causing officers to choose to resign.

From a career counseling and officer assignment perspective, it is doubtful that the results of this study will cause any major policy changes. Nonetheless, it is important to understand that variety in officers careers from time outside of the primary occupation in joint, security, recruiting, and drill fields had a positive effect on retention decisions. Contrarily, high PMOS and FMF ratios were viewed as negative by both the promotion process and by officers deciding whether or not to continue service. In a time of budgetary constraints and the need to find news ways to shape the officer force, herein lie pursuable possibilities.

B. LIMITATIONS

Although the data used for this study was quite extensive, there was missing information in certain categories as well as missing variables. Additionally, there still remains a group of data files that must be appended to create a data set with the maximum amount of explanatory power. For some variables, such as marital status, or a change in primary occupation, specific dates for these variables were not present. It was possible to work with the data as is; however, more precise data may provide a fuller career picture for detailed analysis. For other variables such as prior enlisted records or education, the data was simply not available. With the advent of the Marine Corps Total Force Data Warehouse, it may be possible to fill in some of the gaps in the data. This will depend on how strong the warehouse becomes.

This study used data from 1980 to 1999 based on the parent MCCOAC data file. To find general trends, cohorts were followed for a 10 to 11 year period. Cohort data was available from DMDC; however, it did not have all of the variables needed to conduct this analysis. The main missing factors were fitness report data, TBS data, prior enlisted factors, and economic data. If these variables could be appended into a single data file up to the present year, a much more robust study could be conducted.

Another limiting factor was the fitness report itself. As has been mentioned on previous studies, the available old fitness report data available has only section A and

section B information. The main piece of information missing was the reporting senior's numbered ranking of officers under their charge—a ranking of all outstanding officers from highest to lowest. Additionally, with the change to the new fitness report, some kind of cross fitness report scaling should be conducted so that performance indicators can be used from early data up through current data.

If a greater amount of data were available, this could alleviate problems associated with a limited amount of observations. Studies could be conducted over a longer time horizon to find out how assignments affect the careers of officers up to the promotion point of lieutenant colonel. In this way aviators could more easily be added to the study. An over-sampling of female and minority officers could also be used to compare their careers, promotion rates, and attrition to white, male officers.

Finally, this study used only information available from record data sources. As there are currently exit surveys used in the Marine Corps, a qualitative study of that data could be used as a validation tool for this type of quantitative study. It would also be interesting if surveys were administered after the promotion process. An analysis could be conducted based on the impressions internal to the board, as well as the impressions of reporting seniors and the officers themselves.

C. RECOMMENDATIONS

This study found evidence that PMOS and FMF ratios above 60 percent both increased the likelihood of attrition and predicted a reduction in the probability of promotion. The study also found evidence that having "B" billets outside the PMOS decreased the likelihood of attrition. One pursuable, low-cost option, would be for the Marine Corps to modify the assignment process to ensure the PMOS and FMF ratios of officers did not exceed 60 percent. Additionally, the distribution of "B" billets could be modified to ensure officers in all PMOSs have an equal opportunity to serve in these billets—this may provide a method to reduce attrition in chronic low-strength PMOSs.

The overall recommendation from this work is for researchers to continue to find additional pieces of information available in the data. There is a wealth of undiscovered data such as the codes, flags, and dates on fitness reports used in this study. As data becomes more available, and as data collection becomes more precise, the limitations on

studies will only be in the minds of the researchers. It will be important to explore new data sources and find ways to integrate that data with other data sources. A first step would be to construct a data file which contains the current cohort data from DMDC, the MCCOAC data from CNA, and to add to that file prior enlisted data, fitness report data, and economic and pay related data.

One main data problem is that it changes, or has changed, over time. Somehow old data needs to be converted into a usable form that is compatible with new data. The Marine Corps fitness report is a perfect example. As discussed in the limitations section, some scaling system should be devised so that performance data is seamless between the past and present periods. In this way studies will not be subject to a time constraint, which may force the researcher to use limited new data or continue to come up with new ideas using old data.

The limitations discussed above provide ample opportunities for continued studies in the area of assignments. One natural continuation would be to use a similar methodology to study promotion to lieutenant colonel and discover what causes attrition of officers after selection to major. Given a system to deal with the change in fitness reports, more cohorts could be added to the current study to see what effect the last five years has had on promotion and continuation. Additionally, a similar type of analysis could be applied to the enlisted side of the Marine Corps.

One area that needs specific attention is at the individual PMOS level. Limitations in sample size have caused most researchers to put PMOSs in groups. This has provided generalized conclusions, but no specific information for any one particular PMOS. Especially in the areas of retention and attrition, as more data becomes available, a longitudinal study incorporating PMOSs down to the occupation level should be conducted.

Other areas for research apply more directly to this study. There is a wealth of data available from the Promotion Branch, Headquarters Marine Corps. It may be possible to match promotion zones to specific records for a more accurate look at time to promote and more accurate information about economic factors at the time prior to the convening of promotion boards. From the fitness reports, given more observations, it

may be possible to compare performance before, during, and after "B" billets to determine what effect these tours had on overall performance. Additionally, how PMOSs perform inside and outside their specified occupations could be determined. Performance could also be studied in the same way prior to, during, and after non-FMF billets.

In closing, refer back to the opening quote by Einstein. "Whoever does not know [the mysterious] and can no longer wonder, no longer marvel, is as good as dead, and his eyes are dimmed." Which door the researcher attempts to open is limited only by the imagination.

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APPENDIX A. HECKMAN PROCEDURE STAGE ONE RESULTS

Table 11. Stay Estimates – Stage One – Promotion to Major Model using the Heckman Procedure

	PROMOTION TO MAJOR (3)	PROMOTION TO MAJOR (4)
	Stay coefficients Model (3)	Stay coefficients Model (4)
OCC	-0.122 (0.045)***	-0.123 (0.045)***
NROTC	0.133 (0.040)***	0.133 (0.040)***
USNA	-0.037 (0.051)	-0.037 (0.051)
ECOMM	0.349 (0.071)***	0.348 (0.071)***
TBSPERC	0.362 (0.055)***	0.363 (0.055)***
MARRIED	0.278 (0.072)***	0.278 (0.072)***
BLACK	0.122 (0.063)*	0.122 (0.063)*
HISPANIC	-0.096 (0.091)	-0.096 (0.091)
OTHER RACE	0.067 (0.092)	0.067 (0.092)
COMM. AGE	0.071 (0.010)***	0.071 (0.010)***
DEPN	0.115 (0.072)	0.115 (0.072)
MOS_SERVICE	-0.123 (0.073)*	-0.120 (0.073)*
MOS_GRNDSUPT	-0.067 (0.033)**	-0.066 (0.033)**
MOS_AIRSUPT	-0.192 (0.048)***	-0.190 (0.048)***
PRENL	-0.078 (0.059)	-0.078 (0.059)
COMMEND	1.341 (0.037)***	1.341 (0.037)***
ADVERSE	-0.105 (0.125)	-0.105 (0.125)
DISCIP	-0.296 (0.130)**	-0.294 (0.130)**
DONOTPROM	-0.394 (0.084)	-0.394 (0.084)
Constant	-3.194 (0.228)***	-3.197 (0.228)***
Observations	8881	8881

(Source: Author)
Note: Standard errors in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

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